The Evolution of Architectural Pedagogy in the Age of Information:

Advancing technologies and their implementation in architectural pedagogies

by

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A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved November 2012 by the
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ARIZONA STATE UNIVERSITY

December 2012

ABSTRACT

The contemporary architectural pedagogy is far removed from its ancestry: the classical Beaux-Arts and polytechnic schools of the 19^{th} century and the Bauhaus and Vkhutemas models of the modern period. Today, the “digital” has invaded the academy and shapes pedagogical practices, epistemologies, and ontologies within it, and this invasion is reflected in teaching practices, principles, and tools. Much of this digital integration goes unremarked and may not even be explicitly taught.

In this qualitative research project, interviews with 18 leading architecture lecturers, professors, and deans from programs across the United States were conducted. These interviews focused on advanced practices of digital architecture, such as the use of digital tools, and how these practices are viewed. These interviews yielded a wealth of information about the uses (and abuses) of advanced digital technologies within the architectural academy, and the results were analyzed using the methods of phenomenology and grounded theory.

Most schools use digital technologies to some extent, although this extent varies greatly. While some schools have abandoned hand-drawing and other hand-based craft almost entirely, others have retained traditional techniques and use digital technologies sparingly. Reasons for using digital design processes include industry pressure as well as the increased ability to solve problems and the speed with which they could be solved. Despite the prevalence of digital design, most programs did not teach related design software explicitly, if at all, instead requiring students (especially graduate students) to learn to use them outside the design studio. Some of

the problems with digital design identified in the interviews include social problems such as alienation as well as issues like understanding scale and embodiment of skill.

to my mother . . .

ACKNOWLEDGMENTS

First and foremost, I would like to express my gratitude and appreciation to my Chair, Dr. Beverly Brandt, for being supportive, having faith in my research ideas, and being an inspiring researcher and educator. Without her endless support this dissertation would not have been possible.

I also wish to extend my appreciation to my committee members, Dr. Claudia Mesch and professor David Newton, for their continuous support and encouragement, as well as their valuable contributions to this research. Their expertise and knowledge has greatly enriched this humble achievement.

Thanks also to faculty members Andrew Kudless, Jason Griffiths, Jose Bernardi, and Dr. Renata Hejduk for their interest in my research topic and for providing advice and guidance. Special thanks to Dr. Hejduk and Assistant Professor Griffiths for connecting me with some of the influential individuals whom I had the honor to interview; they have contributed great richness to this research.

Also my deepest appreciation goes to all the participants in this research: Bruce Lindsey (Washington University, St. Louis), Jason Griffiths, Darren Petrucci (Arizona State University School of Design), David Gersten, Elizabeth O'Donnell (Cooper Union Irwin S. Chanin School of Architecture), Dr. David Gerber (University of Southern California), Evan Douglis (Rensselaer School of Architecture), Gil Akos, Ronnie Parsons, William MacDonald (Pratt Institute), Dr. Greg Lynn (University of California Los Angeles), Jason Johnson, Thom Faulders (California College of the Arts), Mohsen Mostafavi (Harvard University School of Design), Nader Tehrani, Skylar Tibbits (Massachusetts Institute of Technology), Omar Khan (University of Buffalo School of Architecture and Planning), and Philip Anzalone (Columbia University Graduate School of Architecture, Planning and Preservation). Despite their hectic schedules, they made the time to meet with me and answer my intense, detailed interview questions; they were generous with their time, advice, guidance, and of course in the sharing of their valuable knowledge. Great appreciation also to professor Andrew Kudless (California College of the Arts) for his time and recommendations for this research; unfortunately technical issues affected the quality of our interview audio, forcing me to exclude his input from the study.

Finally, I extend my sincerest gratitude to Dr. Jawaher Albader for her continued support and advice, not only concerning my academic goals, but also my health and well-being. Despite her obligations, she acted as family for me, serving as a patient listener to my worries and sometimes nonsense through this intellectual mission.

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PREFACE

During the Industrial Revolution of the 19^{th} century, artists and designers discovered a new understanding of the meaning of everyday artifacts. Tools and technology have served to enrich human power, improve accuracy, and be the capacitating devices that define our unique ability to make new tools. The manufacturing process is a cycle of desire designed to reach new needs, where more-sophisticated machines are made possible by the existence of earlier machines.

This ongoing effort to enhance the production process continually introduces designers to new tools. It is the designer's responsibility to adapt the different elements according to the latest tools used within the design process. In 1901, Frank Lloyd Wright proposed that society should regard the study of the machine at work as the first duty of the modern designer. He attempted to outline the designer's proper relationship with the machine in his lecture "The Art and Craft of the Machine." By the word "machine," Wright meant technology in general. "The machine is capable of carrying to fruition high ideals in art—higher than the world has yet seen!"[1] Wright predicted that traditional design would fade to an extent, losing its inspiring effect on shaping the future world, and suggested that—for design to remain a creative influence in the present, as it had been in the past—the designer must embrace current technology.

Wright believed passionately that the machine somehow had to shape aesthetic values as well, not only in design, but also in architecture, art, and all creative work. Artifacts would have to be produced differently in the age of the machine, and as a result, their appearances would

[1] Frank Lloyd Wright, *Frank Lloyd Wright Collected Writings* (New York: Rizzoli, 1992), 59.

also be altered. Mechanization changed aesthetics. Wright believed in a future in which designers would adapt machines to their process:

> a hope has grown stronger with the experience of each year, amounting now to a gradually deepening conviction that in the Machine lies the only future of art and craft—as I believe, a glorious future; that the Machine is, in fact, the metamorphosis of ancient art and craft; that we are at last face to face with the Machine—the modern Sphinx—whose riddle the artist must solve if he would that art live—for his nature holds the key.[2]

He argued against the hand-crafted aesthetic of John Ruskin and William Morris and in favor of an architecture that would use the machine as an aesthetic inspiration.

Although Wright worried that a division in the design-machine relationship would surface, major art and design schools roughly 20 years later were inspired by new challenges due to technological advancements. Architectural and design schools, such as Germany's Bauhaus and Russia's Vkhutemas, were empowered by focusing on manufacturing and technologies in their philosophies and realized the designer's new role within the process.

Walter Gropius, a German architect and the founder of the Bauhaus, sought to emphasize the mechanical side of design and later said of the Bauhaus: "Our objective was to eliminate every drawback of the machine without sacrificing any one of its real advantages. We aimed at realizing a standard of excellence, not creating transient novelties."[3] Yet, Gropius too desired to see the synthesis of art and technology about which Wright had expressed concerns. Gropius notes:

> Our ambition was to rouse the creative artist from his other-worldliness and to reintegrate him into the workaday world of realities and, at the same time, to broaden and humanize the rigid, almost exclusively material mind of the businessman. Our conception of the basic unity of all design in relation to life

[2] Ibid., 59.
[3] Walter Gropius, *The New Architecture and The Bauhaus* (Cambridge, MA: MIT Press, 1965), 45.

> was in diametric opposition to that of "art for art's sake" and the much more dangerous philosophy it sprang from, business as end in itself.[4]

The Bauhaus faculty implemented this constructivist philosophy into their teaching and thus created new principles that emphasized the utilization of design for production purposes. In short, the Bauhaus pedagogy meant to bring together the aesthetic with the industrial.

In *The New Architecture and the Bauhaus*, Gropius describes the struggle of the Arts and Crafts movement of 1850–1915 to reunite the world of art with the world of industry. Commerce, particularly industry, began to look toward artists attaining a higher aesthetic for their artifacts. Although manufacturers bought artistic conceptual designs, they could not be developed into successful, usable artifacts; there was something missing. Thus, instead of relying on manufactures alone, society needed a new craftsman, a creative soul familiar with technical as well as artistic skill to assimilate conceptions of form into the processes of manufacturing. However, this new designer did not yet exist.

Through their pedagogy, the Bauhaus and Vkhutemas schools tried to solve the problem of combining imaginative design and technical proficiency. They looked for new and hitherto unimagined collaborations between the designer and the design process, which could be integrated into the end result. The Bauhaus and Vkhutemas basic design courses—Vorkurs (Foundation course) at the Bauhaus and the Basic Division at Vkhutemas—functioned as laboratories for creating practical new designs for present-day artifacts and improving models for mass-production. The Bauhaus and Vkhutemas believed that the difference between industry and handicraft was due more to the different nature of the tools applied in each than to the subdivision of labor. Instead of separating the industrial model from a cottage type means of

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[4] Gary A. Olson, *Rhetoric and Composition as Intellectual Work* (Carbondale: Southern Illinois University Press, 2002), 194.

production, the schools believed strongly in the processes of specialization and the belief that the two would be united by consistently evolving type-forms for mass-production. Through their forward-thinking attitudes, the "unity of art and technology"[5] came into existence, echoing their constructivist philosophies. Constructivism can be defined as that which rejects art for art's sake, placing the artist in the role of a constructor—that is, one who uses scientific and artistic principles in the service of redesigning ordinary objects and integrating science with art.[6]

The aesthetic modes of the Bauhaus and Vkhutemas schools have become commonplace as an international style of architecture. However, contemporary architectural pedagogy remains under the influence of the constructivist teachers working at both schools during the early 20th century. After the schools' political fragmentation in the 1920 and 1930s, the major architecture schools in Western Europe and the United States were often staffed with Bauhaus and Vkhutemas graduates. Since then, progressive thought has continued to formulate ideas using these schools as the bedrock foundation of their practices. The effect of mass production, scientific engineering, and integrated technology embodies new aesthetic theories that dominate today's architectural practice and education.

Throughout the last century, this dynamic relationship between the stages in mass production, customization, and the high speed information age has led to this moment where we must investigate the benefits of these advancements on architecture. In order to understand the direction of architecture education and practice today, it is essential to undertake this task.

This dissertation explores how technological paradigms (like those used in the Bauhaus or Vhkutemas schools) have changed architectural pedagogy. It identifies the paradigms'

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[5] Gropius, *The New Architecture and The Bauhaus*, 45.
[6] Ibid.

contributions to innovations in pedagogy and seeks to discover how these contributions will lead to further advances in architecture education, theory, criticism, and practice.

Using a grounded theory approach coupled with phenomenological methods, the aim of this research is to trace the strands that will lead architecture instructors to a middle-range theory—that is, an emerging theory of instruction and best practices grounded in the interview data. Through the analysis of interviews with instructors who hold diverse views on technologically engaged pedagogy, the researcher gathered a set of related ideas through codes, then concepts, and finally categories that have lead to the middle-range theory.

The interview questions explore the following matters:

- The relationship between historic and contemporary architectural pedagogy,
- The evolution of technology and architectural pedagogy,
- The influence of technology and technological paradigms/philosophies in contemporary architectural pedagogy and practice,
- The (dis)advantages of technological dominance in contemporary architectural pedagogy.

The purpose for selecting advocates and skeptics of a technologically-informed pedagogy is to provide a broad and balanced view of the practice of teaching architectural history and design and to create/generate a theory for the future direction of architectural pedagogy. This research fills a gap in the present literature by providing insights that can be used to improve current and future practice. It offers a theoretical addition to the literature by evaluating the underlying philosophies of architectural pedagogy as they relate to the role of the machine.

The Outline of this Dissertation

Chapter 1 provides a detailed introduction to the work, describing its significance and providing justification for the importance of considering architectural pedagogy and its interaction with technology.

Chapter 2 provides a background, from 1900 to 2012, orienting readers to the conversations to which the work contributes and showing where this study fills gaps in the literature. It includes information about historical modes of architectural pedagogy (especially the Vkhutemas and Bauhaus schools of the 1920s and 1930s, which represent the first flowering of modern architectural pedagogy). As such, this section details what the literature reveals concerning digital architecture as a field and as a body of knowledge, the history and theory of architectural education, and specific areas of digital architecture and pedagogy. Insights gleaned about fabrication and materials, collaboration, cognitive design elements, hybrid objects, and open source development are also presented. The literature review focuses on the practice of digital architecture, both as an individual exploration and as a coalescing field. Included is the history and theory of architectural education. The goal of this literature review is to provide a foundation for considering the theoretical and pragmatic aspects of architectural education. That foundation has supported the development of the existing research and also hinted at where further research is needed. This section/chapter focuses on analyzing the history, philosophy, and theory of both design literature and education as they relate to fundamental shifts in the nature of technology from the late nineteenth century to the contemporary global scene.

Chapter 3 focuses on research method and methodology. It describes why phenomenology was chosen as an approach for this work. This section also discusses the interview process; sampling protocol; interview questions; elements of the research that should be considered, such as ethics and reliability; and how the method attempts to get at the essence of architectural pedagogy. It also describes how and why grounded theory was applied to help locate the substance of architectural pedagogy, highlighting it as a proven approach to locating discoveries when coupled with phenomenology. Grounded theory helps to tease to the surface middle-range theories about the research at hand. Significant middle-range theories resulting from the study will be reported in the conclusion.

Chapter 4 presents and discusses the research findings. Themes and critical perspectives found in the interviews appear in this section to identify specific trends in architecture education related to the issue of fabrication technology. This section branches in several directions, allowing for the development of multiple perspectives of digital architecture and its integration into education.

Chapter 5 concludes the study by describing the findings, providing critical reflection regarding the outcomes of the research and research issues, and discussing how the study results elucidate the future of architectural pedagogy.

Appendices provide supplemental and background information used and referenced in the paper to provide support for the research as well as to expand the information available for reviewers of the research. These materials include:

- semi-guided interview scripts,
- brief biographies of architectural instructors and professors who have consented to have this information included in the paper,
- Institutional Review Board (IRB) approval, and
- other relevant information.

CHAPTER 1: INTRODUCTION

The structures that we inhabit are no longer simply a set of building materials and aesthetic dimensions; rather, through the inclusion of technological models and paradigms, buildings have become dynamic, functional entities. This research examines the ways in which this dynamism is transmitted through pedagogical practice. The study is designed to explore not only the practice of architectural pedagogy, but also its fundamental philosophical foundations and its approach to the use of technology. Such perspectives are increasingly relevant in the current, ever-reliant, and ever-progressive technological architectural environment, and they will continue to be important as architectural design is more and more directed toward development of the architectural object in accordance with technology.

The practice of digital architecture is a relatively recent development that complements, or in some cases replaces, traditional architectural techniques. For example, digital methods such as parametric modeling, which evolved from computer aided drafting (CAD) and design methods developed in the 1980s, have become the dominant practice over manual drafting and rendering methods for several reasons, including more efficient experimentation as well as a higher degree of architectural manipulation. Contemporary digital architecture is, in its many guises, less than a decade old. Its varied methods, derived from mathematics, computer science, and biology as well as other scientific fields, have not yet firmly settled into the framework of traditional architectural methods. However, digital architecture has not coalesced into its own field either. In fact, as a field of study, digital architecture can best be characterized as rapidly evolving while splitting apart at the ends. For example, the areas of nano-architecture, virtual environment design, and biomimicry all originate from the field of digital architecture. The fragmentation caused by the myriad uses of technology in architecture allows the field to venture constantly into new and unfamiliar realms.

Despite this lack of clear direction, the pedagogy of leading architecture schools has enthusiastically adopted digital tools and design. This integration involves the teaching of, and experimentation with, digital architecture coupled with traditional approaches (e.g., parametric modeling, or the use of performance parameters to semi-automatically generate a range of designs to choose from), which currently constitute a well-founded and robust area of architectural practice. Newer methods are also integrated, including iterative or indexical architecture and biomimetic architecture, which in some cases are so experimental that they have not yet been fully integrated into active practice.

Yet, the implementation of highly experimental methods in architectural pedagogy is not unique. Two foundational schools of modern architecture and design, the Bauhaus (located in Weimar, Dessau, and Berlin and evolving into the New Bauhaus in Chicago) and Vkhutemas (located in Moscow), also reacted to contemporary advancements in technology, changes of intentions, and progressive use of architectural design. Rather than waiting for these methods to become established practice in the post-educational field, the schools directly integrated them into their pedagogies. Nonetheless, this implementation was not without criticism; many other architectural instructors of the era resisted the desire to move architecture in a new direction and instead adhered to more traditional methods of pedagogy and design.

When examining these schools from the first half of the 20th century, it is important to understand their relationship to architecture and design schools in the beginning of the 21st century. In particular, the similarities in the adoption of materials management techniques (i.e., the use of materials for specific structural properties rather than aesthetics) and pedagogy used by contemporary schools of digital architecture, as well as those of the Bauhaus and Vkhutemas schools, provide a point of pedagogical comparison. They offer a means of understanding the historical context of the pedagogical approach to architecture used today. The use of new materials management techniques is not the only change in the contemporary environment compared to historical periods. The adoption of cognitive design elements, mass customization (or "the use of flexible processes and organizational structures to provide a variety of products and services that are designed to individual customer specifications"[1]), collaboration work and tools, hybrid objects, and the open source development paradigm (in which software code is shared freely) have added complexities to the process of design. For further exploration of these subjects, review Chapter 2 of this dissertation.

Aims and Objectives

The research seeks to:

- Understand how technological paradigms shape architecture and design pedagogy,
- Discover the ramifications of the relationship,

[1] Charu Chandra and Ali K. Kamrani, *Mass Customization: A Supply Chain Approach* (New York: Springer, 2004), 4.

- Examine how this relationship and its implications influence further advances in architectural pedagogy, and
- Explore the academic discussion of this interaction through the literature review.

This work is significant because it examines the ways in which an increasing reliance on machines in architecture is transmitted through pedagogical practice. It explores not only the practice of architectural pedagogy, but also its fundamental philosophical foundations in the use of technology. Essentially, the dissertation examines how the "digital" is invading the academy and shaping practices within it.

Research Questions

Certain epistemologies underline both the historical and current approaches to architectural pedagogy. What they are and how they are connected through evolving ideas of architecture education are concerns of this research. Digital fabrication and mass customization, cognitive design environments collaboration theory and the use of information technology for collaboration, hybrid objects, and open source nature are all examples of contemporary technological changes that have influenced architectural pedagogy and practice, but to what degree? To realize this and the current gaps, limitations, potentials, and strengths of the use of technology in architectural pedagogy requires documenting the view of contemporary instructors. Understanding these facets of technologically-based architectural pedagogy through the critiques by both historical and contemporary individuals firmly rooted in the field is crucial in predicting how the field itself will progress.

CHAPTER 2: BACKGROUND

This literature review and analysis examine the evolution of architecture, focusing on the influences of evolving technology, pedagogy, and relating ideals. With this, it is apparent that both technology (ranging from ancient tools to modern computer software) and ideals (including concepts such as modernism and utopianism) have played major and somewhat intertwined roles throughout the history of architecture. Early technologies, including crude levers, pulleys, and material science, allowed builders to improve their capacities to construct in terms of precision, speed, size, strength, and other improvements. The first half of the 20th century was wrought with war and economic challenges, but amid these challenges were major advancements in technology in numerous fields. Later, the 1950s through 1970s would give rise to changes in architectural design and pedagogy through compounded improvements in technology and mass production, which would revolutionize the design of residential and commercial areas in a way that remains foundational to this day. The improvements in communications and transportation technology accelerated developmental potential in these areas, providing the capacity to share ideas and organize massive efforts for major or revolutionary improvements in experimental designs or overall practices. All of these developments in technology for mass-producing had a major impact on the development of architecture over time.

With this, tools and capacity helped to increase demand, and the general improvement of mechanization became a key goal. In parallel with this was the general modernization of various elements of industry and the development of society as a whole, and the current architectural environment then became accessible to any area commonly considered desirable across society. The utopian and dystopian visions of modernism can be set apart from general modernism in terms of the majority of their traits, but they share the same development direction of improving aspects for an update in society that has been applicable in (and influential to) dynamics in architecture. Overall, it is clear that these two outlooks have had the greatest influences in architecture over time.

This discussion and analysis explore these influences in architectural developments over time, reviewing the history of technology in design as well as relevant theoretical influences, such as modernism and utopianism. With this focus, the following explores the introduction of technology in architectural developments, beginning with pre-computer technology, spanning developments ranging from those implemented in ancient and early times through those implemented in the 1960s. Following this, the contemporary influences in architecture that have been possible through digital technology are described, and the section explains how the rapid changes in architectural development have revolutionized a myriad of fields.

Meanwhile, apart from direct technological developments and implementations, changes in theory and schools of thought have affected architectural developments; this review and analysis of literature integrates these theoretical influences on the use of technology in architecture as well. Other aspects of architectural development, such as architectural education, design pedagogy, and art, are also given further consideration. Overall, it is evident that both technology and the theory of pedagogy have greatly influenced many developments in architecture, and this is especially true when examining their combined effects.

20th Century: 1900–1950

War and economic challenges defined the first half of the 20th century, but despite these difficulties, major advancements were made in technology in numerous fields. The improvements in communications and transportation technology accelerated developmental potential in these areas, improving the capacity to share ideas and organize massive efforts for major or revolutionary improvements in experimental designs or overall practices. In line with these improvements in communication and transportation, theoretical changes and intercultural influences increased, with improvements in materials acquisition and transportation further expanding the capacities for architectural development.

Other revolutionary changes in the approach to architecture were more commonplace during this century, and there was an increased potential for international influences. According to Dabrowski, Dickerman, and Galassi, the constructivist movement initiated in Russia (through the efforts of Rodchenko), but had major influences across Europe and eventually the United States; here, the authors report:

> In evaluating Rodchenko's legacy, both for the Russian avant-garde and for Western art more generally, we find the uniqueness, the incredible diversity, and the versatility of his talent coming to the fore with an overwhelming strength. He was the pivotal force behind the formation not only of the constructivist doctrine but also of the school's practical artistic achievements. The richness of his artistic inventions, their experimental nature, and their impact on the work of younger generations in many areas of creativity . . . continue to surprise us to this day.[1]

[1] Magdalena Dabrowski, Leah Dickerman, and Peter Galassi, *Aleksandr Rodchenko* (New York: Museum of Modern Art, 1998), 18.

Rodchenko's developments are an example of the desire for improvements and change in the first half of the 19th century, although they influenced Russia and Europe for decades before influencing the Western world (which was influenced to a lesser extent). Rodchenko himself initially began the majority of his revolutions in art, particularly in painting, but would move beyond this to develop three-dimensional constructions that would begin to influence architecture. With a primarily utilitarian focus, these constructions were as much idealistic and cultural as they were technological and developmental. They were a new vision of modern society, and such capable and aesthetically pleasing improvements on existing images were powerful enough to persuade the masses; this was a simultaneously idealistic and technological improvement of architecture.[2]

Other architectural strides made in the first half of the 20th century involved improvements in design and ideals (see sections 3 and 4 for developments in architecture with a predominantly idealistic motivation), and the rise of industry would be catalyst to mass production of tools, materials, and the capacity to do work. The popularity of automobiles, spurred on by the introduction of the Ford Model T in 1908, furthered the potential of construction crews and utility vehicles, and the improvement of power tools affected both independent developments and large organizations simultaneously. The influx of industry following the Second World War further boosted technological output and general economic growth in the United States. This would be the first transition from the post-classical architectural developments in the 18th and 19th century to modernism as it is known today (see section 3 for other conceptual and stylistic developments in

[2] Ibid., 19.

modernism), and the beginning of what is considered modern technology (prior to the information age of today) began to alter the technological potential of architecture at a foundational level.

This part of the 20th century did not involve so many changes in style, despite the modernist and constructivist movements, as it laid the foundation for construction to be more efficient and effective through the aforementioned technology. These combinations of technological improvement and potential would further compound with artistic changes in common buildings (residences and commercial buildings) in the few decades following the 1950s and prior to the information age and would begin to shape the current face of America while influencing developing nations across the world.

In summary, the developments in technology affecting architecture during the 1950s, ’60s, and ’70s were in terms of mass production and industry, improvements in power tools and transportation, materials development and use, a general improvement in ability to supply the growing demand from the compounded effects of the above, and revolutions in design. As mentioned throughout these sections, not all of the influences on architecture have been purely in response to technological capacities; many evolving schools of thought have influenced the nature of architectural design, related art, and the use of technology. This is best organized into separate sections detailing the major movements that have been related to technological development, but independent of short-term and linear improvements. The following sections outline evolution in architecture in two prominent themes, modernism and utopianism, describing the role of culture and technology in the life of architecture.

Significance of Modernist Architecture

Providing a review and analysis of key topics in Peter Gay's *Modernism: The Lure of Heresy from Baudelaire to Beckett and Beyond* offers a detailed examination of several factors important to architecture in the broad area of modernity.[3] Gay presents rationale for the significance of architecture alongside a discussion of the key points of modernism which relate to it; in this regard, Gay presents the view that there is nothing more significant than architecture in modern society because architecture is home to modernist society as a whole.[4] This is agreeable since a common perception of modernist society involves imagery of large buildings, transportation between them, booming businesses, and communications technology to link information between pieces of architecture.

Gay reports on the evolution of modernist architecture and modernist structures from World War I and beyond:

> The first classics in modernist architecture appeared just a few years before the outbreak of the First World War. The trailblazers who designed them did not necessarily agree on much except for their antagonism to the academic establishment… . The semi-official salons that certified time-honored principles—and awed affection for the trusted neoclassical facades, an invincible appetite for mechanical ornament—provided for modernists countless invitations to go their own independent way.[5]

Here, traditionalists commonly assert, for example, that a bank should "look like a bank," having preconceived imagery of Roman-inspired structures governing their concepts of architectural designs shared for all classifications of building types.

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[3] Peter Gay, *Modernism: The Lure of Heresy: from Baudelaire to Beckett and Beyond* (New York, NY: W. W. Norton & Company, 2008), 281–323.
[4] Ibid., 281.
[5] Ibid.

Modernism would begin to change these conceptions, but with considerable resistance. Modernists would encourage experimentation with the presentation of the building across a range of variables; using shapes in innovative ways, integrating previously uncommon or unused materials, using or blending new colors and contrasts, and other radical changes. Modernists had a desire to make things appear new and inventive in architecture, generally guided by these principles alone as opposed to agreeing to any specific ideal or style as the direction of modernism in society.

With the movement's call to abolish the past and create a distinct present, many early modernist structures were against the flow of traditional developments. The nature of these innovations was completely removed from dominant tastes, and there were mixed reactions to these differences. Many even viewed the modernists as radicals who were attacking what was viewed as the prestigious evolution of architectural design principles and culture. Since many classic trends hail back to Greek and Roman times, many modernist proposals and objects were met with distaste or even rage.[6] Some of the more heated clashes and debates occurred in France, with debate topics ranging from the significance and idealism of the Gothic styles to the developmental direction of French cathedrals. Viollet-le-Duc is a prominent example of modernism's struggle in architecture; as Gay reports, "Sounding much like a true modernist, he demanded contemporary solutions for contemporary problems, a modern architecture quite literally built on the foundations of Gothic."[7]

Additionally, Gay states that the rhetorical modernity was not drastic enough for true modernists as they generally admired classics while rejecting compromises with the

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[6] Ibid., 282.
[7] Ibid., 283.

past. Sant'Elia was another major figure facilitating developments along these lines, asserting that architecture in itself was a distinct art which warranted recent technology being subject to artistic judgment. He named glass, iron, and concrete among the most naturally aesthetically pleasing building materials and said they should be continually used in innovative ways in spite of their otherwise 'humbling' value as materials.[8]

Another prominent figure in modernism, futurist Umberto Boccioni had considerable influence in the perception of architecture. He claimed, "In architectural creation . . . the past weights down on the mind of the client and of the architect." In other words, creativity demands a deviation from former trends, whereas architectural innovation "has to start again from the beginning."[9] Futurists preferred the notion of dynamism in their perception of modernity and the facilitation of its direction; meanwhile, the demand to reexamine architecture with contempt for current traditional preferences influenced the developments, motivations, and writings of futurists and general modernists. F. T. Marinetti, the father of futurism and author of "The Founding and Manifesto of Futurism," commented on the decline of religious and mystical influences in architecture in the early-mid 20th century, pointing out that modern developments in residential and city areas could still be beautiful without spiritual motivations and influences. However, to diminish the demand for art integrated within practical buildings, designers would have to take additional steps to add to the aesthetic value. Marinetti was one of many who felt that this was not only unnecessary but that even low-grade materials had a particular appeal in construction, claiming that the steel frames used in construction are the singular most beautiful thing; this, he argued, stems

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[8] Ibid., 284.
[9] Ibid., 284–285.

from the frame symbolizing the human passion for development and continued improvement.[10]

Describing other significant aspects of modernism, Gay points out that engineers had even more influence in some areas of development than architects; this was because they had less knowledge-based limitations, improved problem solving capacities, and were able to efficiently and effectively approach innovation in even large projects. Thanks to engineers, previously un-crossable spaces could be addressed with innovative bridges, and railroads could tunnel through what were once impassable places; this trend would continue for many developments through the 20th century and beyond. The role of the architect remained significant, but the role of the engineer became vital in the innovation that inspired and fueled modernism.[11]

There were other challenges in the presence of modernism in architecture as the increasing tendencies toward innovative engineering, modernism, and the machine called many to question the true roles of these areas in architectural development. Mechanization in particular was met with distaste in the early years of its inclusion, with architects commonly taking a stand against machines replacing men in the field.[12] Gay describes:

> More and more, mechanical devices were replacing unaided human power, and not in factories alone. The typewriter, the transatlantic cable, the fast train, the elevator, the automobile, the vacuum cleaner, and, in building, materials like concrete and steel that made window walls possible, changed life in the factory, the office, and the home forever. What had once been the product of laborious (and expensive) manual

[10] Ibid., 285.
[11] Ibid., 285–286.
[12] Ibid., 288.

> fabrication was more and more being fashioned in large quantities, and far more cheaply.[13]

Meanwhile, fairs served as exhibition points (especially in major cities such as Chicago, London, and Paris) for the potential results of integrating machines with architectural feats. The influence of modernism was far-reaching through these formal shows, bringing innovations to light ranging from tools and building materials to floor plans and electrical devices. Some demonstrations even involved proposals for entire city designs, although the majority of innovations were new takes on existing designs. Gay reports that new placements of fireplaces, windows, window designs, different pitches and styles of roofs, and similar hybrid developments were the most likely to be influential. Yet, entirely radical designs were more difficult to pass off as ideal for upcoming developments. Even now, Gay further reports, it is increasingly evident how radical many of the proposed changes of modernism were. These extreme innovations were effectively significant and influential both in debate and implementation. Additionally, a common challenge in some of the proposed plans was the viable potential that they would actually work in practice, as many proposed developments were either not considered to a fine detail or were outright lies.[14]

The improvement in information storage, sharing, and organization brought about through communications and transportation technology has been a key driver in the span of modernism. The increased frequency of sharing new ideals served to reduce the resistance to new proposals. According to Shaw, the emergence of the knowledge economy replaced the physical landmarks of the modern city with "storage and exchange

[13] Ibid., 288–289.
[14] Ibid., 293.

of information,"[15] changing the perception of power. Meanwhile, Corbusier argued that awareness of modernization growing through the 1970s would lead to reduction in resistance to modern architecture, enabling improved integration of the built environment.[16] However, the desire for technological, architectural, and design evolution actually showed too little skepticism, which could have filtered changes that were not improvements. Corbusier argued that revolution can be avoided, whereas architecture is a necessity amid the ever-growing demand for improved quality and quantity of technology and resources.[17] According to Banham, the futurist and modernist influences on architecture were not discreet, and utopianism also played a role in the development of modernism.[18]

The relationship between modernism and technology sparked the major architectural revolutions that have become the heart of developed societies in the 21st century. Simple building materials are now prioritized, while improvements in communications and transportation technology mean that supply is abundant.. This has substantially increased the influence of utopian and dystopian visions. The concepts and ideals of modernism were paralleled by technological improvement; thus, developments in technology and architecture can be compounded for a greater change than the desire to modernize architecture without improvements in technology. Utopianism, on the other hand, has less parallel with improving technology and knowledge of effective building techniques, but it still has potential for increased implementation and effective integration

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[15] Debra Shaw, *Technoculture: The Key Concepts* (Oxford: Berg, 2008), 26.
[16] Le Corbusier, *Toward an Architecture* (New York: Praeger Publishers, 1972), 269.
[17] Ibid., 269–270.
[18] Reyner Banham, *Theory and* Design in the First Machine Age (Cambridge, MA: MIT Press, 1980), 13–25.

with such improvements in technology. Tafuri states that architecture was commonly perceived as drama in the 1970s and that people were led to see "form without utopia" and expressed a preference for purity."[19]

Utopianism is an attempt to capture abstract ideals that in themselves are only loosely related to architecture. Tafuri argues that attempts to lend ideology to architecture are deceptive in preference to sincere perspectives. However, this has been the case since the Enlightenment.[20] Dystopia is not as entrenched in architecture, having only manifested in conceptual or stylistic form. It is likely that the only true dystopias have occurred under the rules of tyrants (e.g., Hitler or Saddam Hussein), but the influence on architecture is minimal, since buildings constructed in these arguable dystopias were often short-lived or based on non-dystopian visions.

Commercialization is another influence that occurred in parallel with modernity. Architecture was the first of the arts to accept the consequences of commercialization and to use it as a driver of development and change. Modern architecture thereby established a means of developing ideological situations capable of integrating design with the direction of urban, cultural, and consumption-related developments.[21]

Utopianism did not meet all the design needs required. In particular, it ignored the potential for ideological planning to be manifested through architectural methods and lost the practical nature of architectural design.[22] However, it did offer a vision that

[19] Manfredo Tafuri, *Architecture and Utopia Design and Capitalist Development* (Cambridge, MA: MIT Press, 1979), ix.
[20] Ibid., 41.
[21] Ibid.
[22] Ibid., 100.

modernism did not. Utopianism had distinct visions for all of society, while modernism generally sought to improve the image of design in some fashion.

Integration of landscape and architecture was a further influence of utopianism. Schneekloth describes the roles of landscape and architecture in utopian planning, asserting that the common aim of this was and is to make the entire world into something new.[23] He argues about these related fields, "The world already exists; we are replacing and therefore unmaking something else."[24] The utopian take on modernism is also commonly criticized for being overly imperialistic, and its demands to remodel both cities and landscapes lead to declining considerations for implementation since its inception. Another argument is that utopianism is merely a result of people doing practical work through problem solving, constructions, design, planning, packaging, etc., in a way that often reaches a certain level of desirability.[25]

At the level of the individual building, utopian (and especially dystopian) perspectives are difficult to define; while modernism is defined in aesthetic, design, or imagery terms, the utopian perspective is less definable in concrete terms because it is more philosophical. Artistic integration and the attempt to present an image of a utopia are arguably possible but are more subjective with a greater potential to evoke different ideas in different people. According to Schneekloth, "The inability to see and confront the visionary and utopian character of making places enmeshes the environmental design fields in a dehistoricized and uncritical situation . . . characterization of the professional

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[23] Lynda Schneekloth, "Unredeemably Utopian: Architecture and Making/Unmaking the World," *Utopian Studies* 9 (1998): 1.
[24] Ibid.
[25] Ibid., 1–2.

and academic practice of architecture and other design fields is, of course, a simplistic accounting of a diverse and complex practice."[26]

The presence of utopian designs are more reliant on public opinion than the form of engagement, and the best way to avoid the opinions of a single minority vision integrated into the world is through public discussion.[27] As such, imaginative potential and ideologies can be better developed and refined, and the democratic approach is serves to represent the utopian dream of a larger portion of people. Whether this will manifest at a greater rate or to a greater extent than the current levels of utopianism is unknown.

Technology within Architecture Education

The Bauhaus and Vkhutemas

Historical pedagogies at Bauhaus and Vkhutemas

The late 1910s and early 1920s saw a flowering of intellectual and artistic development in Europe that accompanied shifts in the political landscape. One of the major changes in this area was the development of avant-garde schools of industrial design and architecture, which integrated holistic artistic development and design methods with a utilitarian aesthetic and the goal of mass production. The largest and most prominent of such schools were der Staatliches Bauhaus (the State School of Building), initially established by Walter Gropius in Weimar in 1919 before moving to Dessau and

[26] Ibid., 17.
[27] Ibid., 21.

then Berlin, and the Vkhutemas (the Vysshiye Khudozhestvenno-Tekhnicheskiye Masterskiye, or Higher Art and Technical Studios, often termed the Russian Bauhaus), founded in Moscow in 1920.

These schools, although different from each other in location and cultural identity, maintained similar aesthetic and philosophical approaches to design and to the role of design in everyday life. They shared students, faculty, and teaching methods and practices. Tragically, the two schools also shared a short lifespan; the Vkhutemas disintegrated under the weight of internal political pressure by 1930, and the Bauhaus closed in 1933 due to the Nazi regime. This section explores, through historical accounts and narratives, primary source documents and elements of art and design derived from each of these schools, how these two schools developed in relation to each other, as well as what influence the Bauhaus and Vkhutemas schools had on social and artistic thought in Europe following their period of ascendancy.

History of the schools

Both the Bauhaus and the Vkhutemas grew from the development of the avant-garde movement in the early 1900s. The avant-garde movement is a designation for a group of schools of art that were defined by rejection of traditional techniques and aesthetics.[28] The movement was characterized by internationalism, extremism, and a historical view that positions it against other movements, including romanticism and

[28] Matei Călinescu, *Five Faces of Modernity: Modernism, Avant-Garde, Decadence, Kitsch, Postmodernism* (Durham, NC: Duke University Press, 1987), 117.

naturalism.[29] Some of the more visible international movements of the avant-garde include fauvism, Dadaism, Italian futurism and the Russian adaption of futurism, and cubism, although even these movements actually represent multiple schools of art and philosophy that engaged with the modernist aesthetic and social contexts differently.[30]

These movements shared higher goals and objectives and were not isolated to an individual artistic event, but instead attempted to diffuse themselves into larger society.[31] Thus, many of the artistic movements can be seen not only in easel painting, but also in other arts: theater, literature, and architecture. From this rather vague categorical definition, it can be difficult to see the origins of the two schools in the political and aesthetic context of the time. A clearer understanding of the aesthetic and social principles of each of the schools is needed in order to understand how they were influenced by—and how they influenced—the architectural and artistic currents of the time.

Historical origins of the Bauhaus

The Bauhaus (der Staatliches Bauhaus) was established in 1919 in Weimar,[32] and its cultural and artistic origins can be seen through the mid-19th century in the ideals of John Ruskin and William Morris. Ruskin, observing the quality of goods and the reduction in quality of life that was brought about by the Industrial Revolution, rejected

[29] Ibid.
[30] Renato Poggioli, *The Theory of the Avant-Garde* (Boston: Harvard University Press, 1968), See throughout for discussion of the rapid changes and modifications of the schools of the avant garde.
[31] Ibid., 26.
[32] Magdalena Droste, *Bauhaus, 1919–1933* (Berlin: Taschen, 2002), 12.

the idea of mechanical production and advocated for a return to individual methods of manufacture.[33] Morris, the founder of the Arts and Crafts movement, enacted Ruskin's ideals by reconsidering the design of everyday objects, not in terms of the ease of manufacture by machines, but instead in terms of aesthetic and construction qualities.[34] The Arts and Crafts movement was based on a utopian vision of craftsman guilds and workshops, each working together across lines of materials and techniques.[35] The 1870s saw the establishment of Arts and Crafts museums in Vienna and Berlin, but the movement itself did not affect the artistic practice in Germany until the Jugendstil (youth style) movement of the 1890s.[36]

The tradition of the workshop, on which the Bauhaus was based, was only implemented in Germany in the early 1900s, following Hermann Muthusius' observation of English craft workshops.[37] This observation led to the introduction of workshops into existing craft schools, as well as to the formation of academies of arts and crafts in Düsseldorf, Breslau, and Berlin.[38] However, this was not a wholesale importation of the English Arts and Crafts movement, but was instead an integration of the workshop structure into the existing aesthetic.

Unlike the English workshops, the German Jugendstil workshops used machinery and standardization of design and did not shy away from modern aesthetics. "Stylistically, too, the German products of the turn of the century had nothing left in common with the English products of the Arts and Crafts movement, which were still

[33] Ibid., 10.
[34] Ibid.
[35] Ibid.
[36] Ibid.
[37] Ibid., 11.
[38] Ibid.

firmly entrenched in the 19th century."[39] In fact, the German handicrafts movement became rapidly integrated into the industrial context. The growth of nationalism in Germany between 1907 and 1914, as well as the growing technological strength of the country, led to the development of the Werkbund, a trade organization that promoted commercial production of handicrafts and specifically designated standards of quality and consistency as well as design.[40]

This period of German history saw the development of an attempt to reconcile "art and the machine"[41] through the structure of the Werkbund and the aesthetics of the Jugendstil. However, it was also a period of pedagogical reform in Germany. Schools under the Reformpädagogik (Reform Pedagogy) enacted activity-based learning methods and comprehensive curricula.[42] These schools were characterized by utopian social ideals of organization as well as progressive social principles including vegetarianism, egalitarianism, and cultural conservation.[43] The onset of World War I introduced considerable discord into this intellectual environment, with initial enthusiasm for the war giving way to rejection, growth of alternative political views such as socialism, and lack of understanding of the direction of the war.[44]

Walter Gropius, a member of the Werkbund, began to discuss the establishment of a school of arts and crafts in Weimar as early as 1915, while still engaged in fighting in World War I. He received several offers for involvement in the Weimar School of Arts and Crafts and the Academy of Fine Arts, but he submitted a proposition to the Saxon

[39] Ibid.
[40] Ibid., 12–13.
[41] Ibid., 14.
[42] Ibid., 15.
[43] Ibid., 15–16.
[44] Ibid., 16.

Ministry of State to open an individual school.[45] The submission, which encompassed the essence of the Bauhaus school, called for elements including cooperation between artistic designs and engineering, multiple aesthetic groundings, and a workshop-style approach to pedagogy.[46] Although this proposal was turned down, in 1919 Gropius accepted a post to head the Academy of Fine Art's new architecture and handicrafts department, while concurrently restructuring the School of Arts and Crafts.[47] This resulted in a merger of the two schools under the name Staatliches Bauhaus, which opened in Weimar in April 1919.[48] The opening of the Bauhaus can be seen to be the culmination of half a century of arts and crafts revolution and design, the development of a unique German interpretation of the Arts and Crafts style as represented by the Jugendstil, and the development of a reform pedagogy that emphasized activity-based learning, comprehensive curricula, and utopian social ideals.

Historical origins of the Vkhutemas

Although the Vkhutemas had similar pedagogical techniques and social orientation to the Bauhaus (and is often called the "Russian Bauhaus"), the historical and artistic origins of the movement are quite different. Like the Bauhaus, the Vkhutemas was founded in the atmosphere of intense nationalism and political change that occurred during World War I.[49] In Russia, this political change was the growing Communist

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[45] Ibid.
[46] Ibid.
[47] Ibid., 17.
[48] Ibid.
[49] Bill Risebero, *Modern Architecture and Design: An Alternative History* (Boston: MIT Press, 1985), 166.

revolution, which brewed within the country's borders and was held in place by a British naval blockade from 1917 to 1920.

While the Bauhaus movement emerged from an Arts and Crafts influence, the Vkhutemas instead emerged from an artistic climate that had rapidly developed over the previous ten years from primitivism to cubo-futurism to suprematism, established in 1915 by Kasimir Malevich.[50] The suprematist movement focused not on traditional aesthetic designs, but on the use of the square, the circle, and the typographic elements of a design.[51]

As with the Bauhaus school, the structure of the Vkhutemas was built on existing schools of art. One notable predecessor was the Petrograd Free Studios (the Petrograd Svomas), formed in response to the political closure of the Petrograd Academy of Art.[52] The Free Studios were formed under the principle that everyone who wanted to learn artistic skills would be taught; if they were over 16, they had a right to enter the school. Additionally, all members of other art schools were considered members.[53] Students were allowed to choose professors and to choose groups they would work in rather than being assigned to anything; this allowed for a freedom of expression, but was also a very chaotic structure that, according to Gray, rapidly dissolved. Regardless of its faults, the same structure was used for the formation of the Vkhutemas.[54] The school's foundation in 1920 was informed by this orientation toward artistic freedom of expression and the

[50] Ibid., 164.
[51] Ibid., 165.
[52] Camilla Gray, *The Russian Experiment in Art 1863–1922* (London: Thames and Hudson, 1986), 231.
[53] Ibid.
[54] Ibid.

political nature of art, as well as the multiple inheritances of the Russian avant-garde movement.

School structure and pedagogy

It is important to note that the structure and pedagogical methods of the Bauhaus and Vkhutemas did not emerge from isolation. Instead, they were the result of social and political changes that encouraged the development of novel pedagogical methods.

School structure and pedagogy of the Bauhaus

The Bauhaus school did not emerge from isolation, but was instead an outgrowth of an experimental educational reform program that began in the bourgeois schools of the Weimar Republic during and after World War I. Initially, the school was based on the ideals of absolute artistic expression that would also inform the Vkhutemas structure and pedagogy.[55] However, as Whitford notes, this rapidly gave way to a more realist approach that focused on the functional value and practices of art rather than artistic freedom.

[55] Frank Whitford, *Bauhaus* (London: Thames and Hudson, 1988), 9.

Curriculum and pedagogy at the Bauhaus

The basic curriculum of the Bauhaus was largely consistent throughout its history. It is described in Wingler's seminal work on the Bauhaus as follows:

> The nucleus of this basic course, inspired by Cizek, consisted of studies on materials (play with various materials, from paper, plaster of Paris, or wood to glass, cane, and even briquettes) to develop a feeling for and an understanding of their specific qualities. The solution to any given problem, compiling materials and using them in three-dimensional composition studies, was restricted only by the individual's imagination. It was an educational process designed to bring to life the student's hidden creative abilities.[56]

This basic course, called the Foundation, included elements of theory as well as exploration and was particularly focused on the physical properties of materials and their effective use. Issues such as balance of materials, folding and cutting, optical illusions, color, line, and composition dominated the introductory curriculum.[57] Although some of these activities were voluntary, this was not the case for all such activities. Two lectures that were mandatory for all entering students included Klee's Educational Sketchbook, which addressed the issue of accurate drawing and rendering of objects (a consistent focus of the Bauhaus curriculum), and Kandinsky's Point and Line to Plane, which further developed the students' skills in rendering and drawing.[58] This shared basic curriculum resulted in a recognizable style throughout the workshops despite their very different focuses and materials.[59] Although the school did not initially have a formal

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[56] Hans M. Wingler, *Bauhaus: Weimar Dessau Berlin Chicago* (Cambridge, MA: MIT Press, 1969), 4.
[57] Ibid., 4–5.
[58] Ibid., 5.
[59] Ibid.

architecture workshop or program, there were various lectures offered that addressed architectural issues, including those in statics and interior design.[60]

One of the most striking features of the pedagogical approach to the Bauhaus school was the integration of theory and workshop learning, in which students were encouraged to engage in active production and design as well as learn approaches to theoretical design.[61] The school used a formal apprenticeship structure inspired by the medieval guild workshop. Rather than studying with individual professors (as at the Vkhutemas), students at the Bauhaus were admitted as apprentices, completing a theory-based course that was required for all students before joining a workshop.[62] The workshops were competitive in nature, with students and teachers actively producing products for the market as a means of gaining experience as well as generating funds for the school. Workshops that were active at various times throughout the school's history included metalworking, theatrical stage work, cabinetmaking, architecture, ceramics, printing, and weaving.[63] (These workshops were not all active at the same time; for example, the move from Weimar to Dessau resulted in the loss of the ceramics workshop, while the architecture workshop was only added after this move.)[64] The workshops represented not only a pedagogical approach, but also a revenue-generation approach. Constrained by the limited budget provided by the state, which was itself highly economically constrained and did not prioritize artistic vocational education, the school had a very difficult time managing its finances and providing for the high materials costs

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[60] Ibid., 6.
[61] Ibid., 5.
[62] Ibid., 4.
[63] Ibid., 5.
[64] Ibid., 6.

of its teaching structure.[65] The workshops provided revenue from the sale of handicrafts produced within them, as well as the revenue from private commissions for works by the masters and students.[66]

These workshops were structured in a unique way. To acknowledge that the artists who held the highest level of skill did not necessarily have teaching experience or any particular desire to teach such skills, the workshops each had two masters.[67] The Master of Form led the artistic direction and provided artistic involvement in the work, while the Master of Craft engaged with students in their teaching duties. Students were considered to be apprentices on initial entry to the workshop of their choice, while further in their artistic development they were considered to be journeymen.[68] The levels of journeyman, and finally master, were assessed by examination with formal graduation between levels being awarded by an apprenticeship board.[69]

The workshop structure would stay with the school throughout its history. However, following the transition to Dessau in 1926 and its designation as an academic school, the school took on a more traditional approach to its curriculum.[70] This shift, which included the reintroduction of the title of professor, suggests a move to the constructivist approach from the deconstructionist approach (although those who had been workshop Masters of Form in Weimar kept that rank). The transition to the Dessau Bauhaus also marked the introduction of a junior teaching staff, which was comprised of Bauhaus-trained artists and educators. This allowed for elimination of the dual teaching

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[65] Ibid.
[66] Ibid.
[67] Ibid., 4.
[68] Ibid.
[69] Ibid.
[70] Ibid., 7.

structure as these former students understood both the teaching methods and the materials in use.[71] In the Dessau workshops a final completion diploma replaced the apprenticeship process.[72] This transition also resulted in increasing departmentalization of the program as the school grew larger and administration became more complex.

Although there was considerable interest in architecture among the Bauhaus students and professors, it was not one of the earlier programs to be integrated into the Bauhaus curriculum.[73] Gropius, the school leader, was himself an architect of growing international renown and had designed the Dessau Bauhaus building to such a high degree that, by 1928, up to 250 people visited each week to inspect the architecture of the building.[74] Despite that, the administration of the school did not lend itself to having time to teach architecture at the level required by the students; thus, although there were occasional lectures in architecture and design, this was not a part of the formal curriculum until the school's move to Dessau.

The architecture program at the Bauhaus was eventually established in 1927 under the leadership of Swiss architect Hannes Meyer.[75] Meyer, who would be appointed director upon Gropius' resignation in 1928, brought international renown as well as some discord to the school. According to Wingler, there was a considerable disagreement between Meyer and the school's pedagogical leader and curriculum designer, Laszlo Moholy-Nagy. Specifically, "What Moholy-Nagy demanded and depicted in his numerous publications was the aesthetic experience, the vision born of a new unity of art

[71] Ibid.
[72] Ibid., 8.
[73] Ibid..
[74] Wingler, *Bauhaus*, 9.
[75] Ibid., 8.

and technology, and the way to the realization of an optical culture, born from a specific visual awareness."[76] In contrast, Meyer's focus and concern was the resolution of practical problems of industrial testing, quality, standardization, and implementation of artistic ideals in mass culture. (Meyers' special focus was in experimental housing units, designed in a number of areas.)

Meyer also brought a distinct Socialist political slant to the school, promoting ideals of involvement at all levels of society rather than the absolute focus on quality that other members of the faculty, including Moholy-Nagy, held.[77] This focus, when applied to workshop production, increased the productive capacity of the workshops and thus helped the school gain financial footing; however, it also reduced the "speculative and playful tendencies of which the Weimar master craftsmen had often complained."[78] In opposition to the previously competitive approach between the workshops, Meyer emphasized cooperation between the workshops and designers within them, as well as a growing influence on the development of affordable consumer goods. Wingler describes the influence of the Meyer era on the curriculum and its outputs as such:

> The genuine, essential, and original attainments of the Meyer era were based on collective work. Thus the trade union school in Bernau, near Berlin, was built in cooperation with the department of architecture and the workshops. "People's furniture" was introduced, which was both reasonable in price and practical, and Bauhaus wallpapers were developed in the department for wall painting… . With a group of "balcony" housing units at the edge of the Dessau-Törten settlement, Hannes Meyer and his assistants in the architecture class put into practice a technically and functionally convincing solution for economical mass housing. Whatever was planned and executed in the field of building and furnishing conformed to the idea of a program for Everyman.[79]

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[76] Ibid.
[77] Ibid., 9.
[78] Ibid.
[79] Ibid.

Meyer's leadership of the school ended messily in 1930, following a disastrous attempt to reform the school's curriculum into a more academic and formal structure, a rejection of the artistic origins of the school.[80] Given a choice between the core instructors of the school, including Albers, Kandinsky, Klee, and Schlemmer, and the removal of Meyer, who had attempted to impose new curricula and focus that would have isolated and marginalized these artists, the board of directors (including Hesse and Gropius) replaced Meyer with architect Ludwig Mies van der Rohe.[81] The transition to Berlin and the leadership of Ludwig Mies van der Rohe once again signaled a change in the curriculum and pedagogical focus.[82]

Mies van der Rohe did not take Meyer's approach of practicality and rapid production, but instead advocated for a return to unbending high quality.[83] This transition changed the curriculum once again. Under Mies van der Rohe's leadership, workshop production almost ceased, and the main emphasis of the school was placed on architecture, planning, and interior decoration (or, more properly, interior design as an integral element of architecture).[84] The deprioritization of art and aesthetics in the curriculum, although it succeeded in developing the architectural focus of the school to a very high degree, instigated other changes. Paul Klee left the school for a professorship in Düsseldorf, and although Kandinsky stayed at the Bauhaus, the artistic element of the curriculum was almost eliminated at that time.[85]

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[80] Ibid., 10.
[81] Ibid.
[82] Ibid.
[83] Ibid.
[84] Ibid.
[85] Ibid., 11.

School structure and pedagogy of the Vkhutemas

As with the Bauhaus school, the structure of the Vkhutemas was informed by the artists who taught and practiced there. According to Gray, "Among those who had studios here were Malevich, Tatlin, Kandinsky, Rosanova, Pevsner, Morgunov, Udaltsova, Kusnetsov, Falk, and Favorsky."[86] However, this artistic influence was also tempered by the political influence of the Inkhuk (Institute of Artistic Culture), which was concerned with the role of the arts in the nascent Communist society.[87] This institute—headed by Malevich in Vitebsk and Tatlin in Petrograd as well as falling under the auspices of the IZO Narkampros (the Department of Fine Arts of the Commissariat for the People's Education) in Moscow[88]—played a significant role in not only the political and social life of the school but its pedagogical policies as well. However, although the Institute was a state organization, it was not founded on the basis of maintaining state control over the artistic and productive life of the school. Instead, it was based on the idea that "art and artists must be absolutely free in every manifestation of their creativity . . . art affairs are the affairs of artists themselves."[89] Paradoxically, as such, the Inkhuk was a state-sanctioned institute and oversight committee dedicated to eliminating the influence of the state in the practice of art.

There were seven departments incorporated into the Vkhutemas, including painting, sculpture, architecture, ceramics, metalwork and woodwork, textiles, and

[86] Gray, *The Russian Experiment*, 232.
[87] Ibid.
[88] Ibid., 231–232.
[89] John E. Bowlt, *Russian Art of the Avant-Garde: Theory and Criticism* (London: Thames and Hudson, 1988), xxxv.

typography.[90] As at the Svomas (the schools in Moscow and Petrograd that preceded the Vkhutemas), students were not assigned to particular departments or instructors, but were allowed to choose where they would participate; students were also not restricted to a single department, but were allowed to study in any group they desired.[91] The pedagogical method was a matter of some debate, and as a result, it changed drastically during the period of the school's practice.

Curriculum and pedagogy at the Vkhutemas

The development of the pedagogical approaches at the Vkhutemas school were guided by the artistic and social ideals that were held by its leading teachers. Vkhutemas (the Higher State Artistic and Technical Workshop) based its pedagogy on that of the State Free Art Studios, which promoted ideals of artistic freedom of expression and encompassed all modern art movements.[92] This inclusivity spanned from state-sponsored architectural models to radical or leftist notions.

The pedagogy of the Free Studios was formative for the Vkhutemas pedagogy. The Free Studios elected their masters (although the candidates were selected by a committee). According to Lodder, the student choice indicated a preference for conservative trends such as impressionism and neo-impressionism rather than more radical schools such as suprematism or futurism.[93] Lodder notes that there could be a number of reasons for this seemingly conservative approach by students, including

[90] Gray, *The Russian Experiment*, 232.
[91] Ibid., 231–232.
[92] Christina Lodder, *Russian Constructivism* (New Haven: Yale University Press, 1983), 109.
[93] Ibid., 110.

loyalty to former masters from the unreformed schools and the selection of the schools against more adventurous styles. Masters were each responsible for their own studios, which focused on traditional arts, including painting, sculpture, and architecture. The Free Studios did offer training in materials, each of which was appropriate to the specific arts (for example, the painting studios taught chemical properties of paints).[94] However, each studio was ultimately run individually with each master's studio taking a different direction. The training was substantially diverse; for example, students were taught to draw in multiple styles rather than spending hours drawing from forms.[95] According to Lodder, the degree of freedom varied widely depending on the studio.

The reorganization of the Free Studios into the Vkhutemas was intended to redirect the artistic efforts of the school toward the needs of mass production and industry; the students were offered deferment of military service, and teachers received extra rations in support of this goal.[96] As Lodder points out, the Vkhutemas pedagogy never solidified or became either static or stagnant; instead, it changed rapidly, during some periods altering, according to instructor Lyubov Popova, on a monthly basis.[97]

Lodder identifies three major periods of pedagogical development at the school, each of which had a different orientation to teaching.[98] The first period (1920–1923) was marked by shifting the Free Studio pedagogy and structure in order to encompass the demands of the industrial mandate the school received from the Soviet state. The second period (1923–1926) was marked by involvement in the development of industry as well

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[94] Ibid.
[95] Ibid., 111.
[96] Ibid., 112.
[97] Ibid.
[98] Ibid.

as a consolidation of pedagogy and teaching practice. The third period (1926–1930) marked an era of increasingly narrow focus on industrial design; this was the final stage of development as the school was dissolved in 1930.

The architectural faculty at the Vkhutemas was split between the faculty inherited from the Moscow School of Painting, Sculpture, and Architecture and the constructivist architects who would eventually gain control of the school's architectural faculty.[99] By 1922, the traditional and modern architects within the school were split into the First and Second Academic Departments, which operated independently. Despite this split, the architectural program was considered to be highly successful.

The course materials of the architectural school of the Vkhutemas were highly diverse and were integrated over five years of study. The course addressed both theoretical and practical materials in various fields including "physics, chemistry, mechanics, perspective, geometry, history of art, and social and political disciplines"[100] during the first two years. In the final three years, there were courses more specific to architectural practice, including history of art and architecture, aesthetics and design, internal systems and construction, and theories of architectural composition. Specific artistic emphasis was placed on architectural volume and surface, its mass and weight, architectural space, and architectural construction.

The arrangement of courses for the second part of the curriculum varied depending on the evolution of the school. During the first half, the course included monumental architecture, planning, communal architecture, and decorative and spatial

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[99] Ibid., 119.
[100] Ibid.

architecture, as well as laboratories and modeling studios.[101] However, by 1926, these courses were rearranged functionally and included courses in "housing, public buildings, factories, and industrial complex," with outside space being added to incorporate decorative-spatial architecture. Lodder notes that this reorganization was due to the changing needs of the state.

In addition to the architectural course, the Vkhutemas had a general study curriculum, Basic Division, that all students were required to take. The course initially spanned two years, but this was then altered to only one year, after which students studied their specific disciplines.[102] This Basic Division, like all the pedagogies of the Vkhutemas, changed rapidly over time.

During the earliest period, the Basic Division covered five different disciplines, including "maximum revelation of color . . . revelation of form through color . . . simultaneity of form and color on the plane . . . color in the plane (suprematism) . . . [and] construction,"[103] all of which were taught from a painterly perspective (including the suprematist and constructivist disciplines). Each of these disciplines had a master who was in charge of teaching all students. By 1925, under a growing influence of constructivism as well as an increased need for more targeted training, the number of *kontsentry*, or concentrations, was reduced to three: color and plane, graphics, and volume and space. Students took all three courses at the lower level during the first year, and during the second year they took a more advanced course in one of these focus areas

[101] Ibid., 120.
[102] Ibid., 122.
[103] Ibid., 123.

as related to their primary field of study.[104] Thus, during this period, architectural students would primarily be taking courses in volume and space. Each concentration was constantly refined to allow students to access the most modern material available. The volume and space *kontsentry* was focused on understanding the concepts of space and volume, their uses, and three-dimensional objects in space.[105] This shift was intended to support later developments of architectural skills.

Internal and external political change and closure of the schools

From its inception, the Bauhaus school was contrary to the social and political currents in Germany at the time. Opposition to the school in its first location in Weimar was based not only on the school's revolutionary teaching ideas, but also the political and personal ideals of its teachers and students.[106] By the mid-1920s, the school was not only facing increasing opposition from the Völkisch government (a right-wing extremist group in Weimar), but also the withdrawal of its state support.[107] In 1925, the Weimar government declared the Staatliches Bauhaus legally dissolved; however, the school was reincorporated in Dessau through the recommendation of art historian Ludwig Grote.[108] The school found a home in the relatively liberal Dessau between 1926 and 1932, where it was supported by the city and formally declared an Institute of Design by the State of

[104] Ibid., 124.
[105] Ibid., 125–126.
[106] Wingler, *Bauhaus*, 5.
[107] Ibid., 6–7.
[108] Ibid., 7.

Anhalt.[109] However, this did not last, and by 1931, the school had come to the attention of the National Socialist (Nazi) party, which began to demand the closure of the Bauhaus in Dessau[110] on the grounds that it bred Bolshevism.

The school was closed in Dessau in September 1932 and moved to Berlin in October. This move would not relieve the political pressure for long. The artists and professors of the school were violently attacked, while "[the] Nazi press denounced the Bauhaus, as they had already done in Dessau, as a 'breeding ground of Bolshevism.'"[111] On the assumption of power by Hitler in 1933, the fate of the Bauhaus was sealed; it was closed by a police raid on April 11, 1933, and was formally closed on July 19 that year by a decision of the faculty.[112] This decision was made only a few days before the Gestapo would offer to allow the school to reopen; the faculty could see no way to continue the intellectual life of the school or to ensure its material support. "It was, at this time, quite clear that even if the Bauhaus had ample funds at its disposal, it would not have been able to maintain itself, progressive and true to its principles, as it had remained to the last hour."[113] The school closed, and the students and professors dispersed around the world, especially to the United States, France, and England, bringing with them not only the Bauhaus design values, but also the progressive social values and modern ideals of the school.

Although the Vkhutemas (known as the Vhuktein by 1925) closed in 1930 under the weight of internal political strife, its foundational ideals continued to be used in

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[109] Ibid.
[110] Ibid., 11.
[111] Ibid.
[112] Ibid., 1.
[113] Ibid., 11.

Russian art and architecture over the next few years.[114] During that time, a shortage of materials and lack of coordination in the Russian state did not allow for any significant projects. Even the artistic practice spawned by the school would not long remain after Stalin's 1932 decree "On the Reconstruction of Literary and Art Organizations" established Socialist Realism as the official (and mandatory) artistic style of the Soviet state.[115]

This enforcement was not permanent. By the 1950s, the phenomenon of unofficial art—art created in contravention of the state requirement for Socialist Realism—emerged following the death of Stalin, which led to the subsequent liberalization of the artistic endeavor.[116] Many of the artistic elements of the constructivist movement that were encompassed by the Vkhutemas were re-established. This can be seen in the works of Vladimir Weisberg, Francisco Infante, and Erik Bulatov, each of whom integrates the form and color of the constructivist movement into their own works. However, the school itself was not re-established, and this style of art remained officially unacceptable within the state.[117]

The long-term influence of the Bauhaus and Vkhutemas schools

Although the Bauhaus and Vkhutemas schools were both in operation for less than fifteen years, they have had a profound influence on the artistic and architectural world both pedagogically and aesthetically. The closure of the schools and the dispersal

[114] Gray, *The Russian Experiment*, 303.
[115] Igor Golomshtok and Alexander Glezer, *Soviet Art in Exile* (New York: Random House, 1977), 84.
[116] Ibid., 85.
[117] Ibid., 86.

of their students and teachers across Europe and the United States during the 1930s, rather than harming the movements, actually spread the influence of the two design schools.[118] One example of this is the establishment of the New Bauhaus school in Chicago by Laszlo Maholy-Nagy, one of the principals of the Bauhaus school, followed by the establishment of the school that would become the Institute of Design, an influential mid-century American design school.[119] Other Bauhaus artists who dispersed across the U.S. include Mies van der Rohe, Walter Gropius (the founder and one of the directors of the Bauhaus school), urban planning professor Ludwig Hilbersheimer, and architects Marcel Breuer and Konrad Wachsmann.[120]

There is less evidence for the dispersal of Vkhutemas principals to the United States. However, there was considerable movement to Germany, and then to France, following the closure of the school and the decree for the reconstruction of the arts. For example, Wassily Kandinsky moved to Paris following the Nazi closure of the Bauhaus school.[121]

The influence of these two schools extended through the artistic realm and into the realm of the politics. The Kitchen Debate, a 1959 confrontation between U.S. Vice President Richard Nixon and Soviet Premier Nikita Khrushchev over the relative development of consumption and consumer goods in the two warring superpowers,[122] took place in an environment where both the Soviet and American consumer goods on

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[118] Victor Margolin, *The Struggle for Utopia: Rodchenko, Lissitzky, Moholy-Nagy, 1917–1946* (Chicago: University of Chicago Press, 1997), 216.
[119] Ibid., 215.
[120] Greg Castillo, "Design pedagogy enters the Cold War: The Reeducation of Eleven West German Architects," *Journal of Architectural Education*, 2004: 10, 14, 18.
[121] Bowlt xxxvi.
[122] Greg Castillo, *Cold War on the Home Front: The Soft Power of Midcentury Design* (Minneapolis, MN: University of Minneapolis Press, 2010) ix.

display stemmed from modern design and manufacture principles derived from the Bauhaus and Vkhutemas schools. The communal residence designed by the Soviet architects as the residence of the future, in which social life rather than individual life was the central element of the home, was derived from Bauhaus and Vkhutemas utopian ideals of collective life.[123]

The manufacture of designed goods for individual use was one of the key design and construction principles similarly explored by both the Bauhaus and Vkhutemas, as was the use of unified design principles across widely varying materials and functional goals.[124] This shared historical influence demonstrates the importance of both the schools to mid-century design in the United States and Europe in terms of creating a bridge between the established Arts and Crafts movements and the modern world.

Although the modern design movements of the West and the East that began in the 1950s were varied in their outcomes, they were very similar in their origins. The role of the Russian and German avant-garde movements, the interest in Arts and Crafts that emerged from the end of the 19th century, the social and political unrest and upheaval and dramatic social change, and the influence of workshop- and activity-based learning pedagogies in both schools led to a development of a curriculum and pedagogy based on desire and experiential learning, the production of practical goods for use, and the rejection of art for art's sake.

These underlying principles were enacted in sharply different ways within the two schools. While the Bauhaus had, for most of its existence, a core theoretical curriculum that was required of students, there was no such curriculum at the Vkhutemas. The

[123] Ibid., 91.
[124] Ibid., 45.

Bauhaus curriculum focused directly on the use of materials as materials, exploring the limits of their use as well as their basic properties as a means of constructing practical goods. In contrast, the constructivist approach used at the Vkhutemas, for the most part, considered materials to be abstract articles to be manipulated and did not take into account the characteristics of the materials themselves when doing so. The Bauhaus maintained a strict and clear curriculum, while the curriculum and pedagogical approach of the Vkhutemas was more free-form, often venturing into areas that could be considered ill-defined or even undefined.

In both cases the schools were founded with a prioritization of the pragmatic over the theoretical, a goal of using art for social improvements, and a belief in the absolute integrity of art and the right of the artist to create as he or she is driven to. These ideals were not always integrated into the curriculum, and they often led to a great deal of difficulty in in the face of disagreement regarding their meaning. The Bauhaus school was diminished by a disastrous reorganization attempt by Meyer before it was ultimately shut down by the Nazi Party in 1933, and the Vkhutemas was closed in 1930 following irreconcilable artistic and pedagogical differences between the members of the faculty prior to dispersing after the 1932 decree that required all art within the Soviet Union to be performed in the Socialist realist manner. However, the students and teachers of these schools did not abandon the aesthetic and social ideals of the schools upon their closure. Instead, they dispersed around the world, bringing both the elements of modern design and the ideals of modern art with them.

The Bauhaus school has a higher profile in the West due to the movement of its students and professors to the United States and the aggressive continuance of Bauhaus design, but the members of the Vkhutemas also spread throughout the world to Germany, France, and other areas, taking with them design and artistic ideals that would resonate through modern art for decades. The development of these modes of art can be seen in the 1959 Kitchen Debates, where both Soviet and American design demonstrated the modern ideals developed at the Bauhaus and Vkhutemas schools during the 1920s.

Architectural Education in the U.S.

Alain Findeli discusses a key moment in American architectural pedagogy with the formation of the American Bauhaus (or New Bauhaus) by Laszlo Maholy-Nagy in Chicago in 1937.[125] Maholy-Nagy had been identified as the best candidate to establish a branch of the Bauhaus in the United States by Walter Gropius, former head of the Bauhaus, who was at the time working at Harvard.[126] The early years of the school's history were tumultuous, with the initial attempt failing in 1938 due to withdrawal of financial support.[127] In 1939, the school reformed as the School of Design in Chicago. The school grew slowly, constrained by World War II and the attendant financial uncertainty and lack of teachers and students. In 1944, under the influence of Container Corporation of America President Walter Paepke, the school reformed as the Institute of Design, attained college accreditation, and moved into a new campus.[128] By the time of

[125] Alain Findeli, "Maholy-Nagy's Design Pedagogy in Chicago (1937–46)," Design Issues, Vol. 7, No. 1 (1990): 4.
[126] Ibid., 5.
[127] Ibid., 6.
[128] Ibid.

Moholy-Nagy's death in 1946, the Institute of Design had 600 enrolled students and 28 teachers.

The main topic discussed by Findeli is not the history of the school (although this is enlightening since it demonstrates the conditions under which architectural pedagogy grew during this crucial period), but is instead the pedagogy itself. The program design was quite similar to that of the Bauhaus, as previously discussed; following a one-year foundation course, students chose from a variety of specialist workshops that focused on a specific craft.[129] Unlike the Bauhaus program, architecture was prevalent from the start of the school's offerings, although ultimately the program would offer far fewer choices. According to Findeli, "In 1938 [the first full year of operation], the proposed workshops were the following: Light, Product Design, Modeling, Color, Stage, Weaving, and Architecture, the latter leading into a two-year master's program… . There remained only four workshops in 1946: Product Design, Graphic Design, Photography and Film, and Architecture."[130] This contraction of workshops showed a reorientation toward the artistic elements that would mark the modern period. During this period, the program lengthened to four years.

Although the curriculum of the New Bauhaus/Institute of Design was based on that of the original Bauhaus school, there were a number of changes made in order to facilitate the needs of the school's new environment.[131] The two most important changes included an increased focus on technological arts (such as film), rather than the traditional arts that were the focus of the Bauhaus (particularly during the earlier years),

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[129] Ibid.
[130] Ibid., 6–7.
[131] Ibid., 7.

and formal training in science, including life sciences, biology, physics, chemistry, and the social sciences.

The underlying didactics of the preliminary course remained similar to those used in the Bauhaus.[132] Specifically, the course taught students how to consider the approach that design involves, which includes "the plastic elements . . . [and] the specific tools and materials used to create form."[133] Students were led through assignments in order to assess their talent and creativity; the preliminary course included elements of each of the specialist workshops, enabling students to discover interest in a given area and facilitate selection for the following years of study.

The preliminary course involved two different types of assignments.[134] In the first assignment, the student was given a plastic element (such as shape, texture, or motion) and asked to explore this plastic element using various tools and materials. The second assignment was an inverse of the first, with a specific tool or material (such as wood, metal, or clay) being used to explore multiple plastic elements. The goal of these experiments was not simply to build skill with a particular plastic element, tool, or material, but instead to gain self-confidence in working with materials and to understand how tools and plastic elements could be used. The experiments also had a specific training purpose; the first assignment taught technological aspects of the artistic process, while the second assignment taught aesthetics. According to Findeli, the preliminary course led students through three stages of learning, including "(1) observation, perception, and description; (2) systematic exploration and analysis; and (3) conscious

[132] Ibid., 8.
[133] Ibid.
[134] Ibid., 8–9.

manipulation and action, leading to the eventual mastery of *design.*"[135] The specific elements of the Preliminary Course are shown in Figure 1.

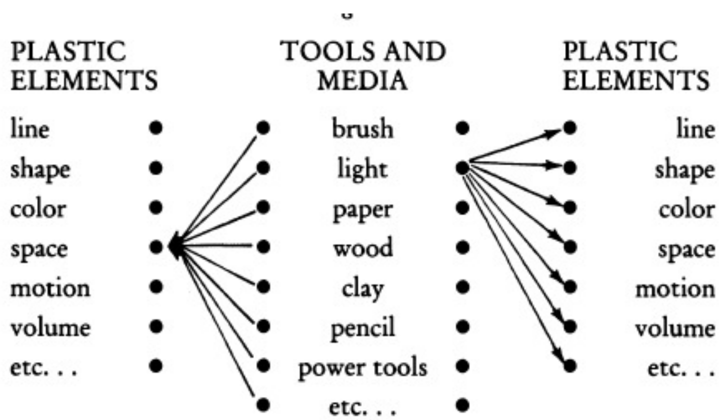

Figure 1. Elements and connections within the Institute of Design Preliminary Course.[136]

Given the nature of this research, the structure of the specialized workshops (especially architecture) is of the most interest. Findeli does not address the Architecture workshop in detail, instead choosing to focus on the Product Design. However, what he does show about the Product Design workshop could be illuminating for the Architecture workshop as well. Findeli describes the workshop as both a place to explore theoretical, philosophical, methodological, communicational, and technological aspects of the particular design problem addressed within the workshop.[137]

There was a specific orientation to solving design problems within the workshop; in particular, the dictum "form follows function" was interpreted to mean that the forms already available (especially those derived from nature) should be used in solving the design problem. This was referred to as organic functionalism. This substantial departure

[135] Ibid., 9.
[136] Ibid.
[137] Ibid., 10–11.

from the Bauhaus pedagogical style (which, according to Findeli, caused significant conflict between Maholy-Nagy and Hannes Meyer, former head of the Bauhaus) was the basis for inclusion of biological and life sciences, as well as physics and chemistry, in the curriculum. Echoes of this sensibility can be seen in the emphasis on biological forms and processes in cybernetics and other schools of architectural design moving forward. The functionalism promoted by the Institute of Design relied on the philosophy of Francé, which differentiated between shape and form and identified seven elementary forms (globe, plane, pole, crystal, ribbon, screw, and cone).[138] Thus, organic functionalism incorporated functionalist (rational, analytical, and technological) and organic (phenomenological and intuitive) aspects to derive design. Organic functionalism was based on the philosophies of Goethe (encompassing "humanistic anti-materialism") and John Dewey (pragmatism).[139]

The design philosophy of organic functionalism was incorporated in the staffing of the Institute of Design through approaches such as hiring teachers who were also artists (in order to ensure that they were "familiar with the intuitive process . . . inherent in artistic practice") and considering the student to be an organic creature, a free agent, instead of only being a knowledge receptacle.[140] The influence of Dewey, a well-known pedagogical philosopher, was particularly relevant given that Dewey visited the Institute of Design and that his book *Art as Experience* was one of the reading selections, at least for the Product workshop. As Findeli points out, concepts such as situation and

[138] Ibid., 12.
[139] Ibid., 13.
[140] Ibid., 14.

interaction, key for understanding the design principles of the Institute of Design, are derived from Dewey's philosophy.[141]

In summary, Findeli's discussion of the New Bauhaus/Institute of Design pedagogy and curriculum shows several key points. First, the structure of the program (especially the preliminary course and advanced workshops) was derived from the structure of the Bauhaus curriculum, but it was significantly more advanced and organized than the original Bauhaus curriculum. It was also more forward-looking and, in particular, had a much higher integration of technology, science, and the technological arts.

The structure of the assignments used in the preliminary course was uniquely designed to perform several purposes. These included increasing self-confidence in the student, allowing for exploration and choice regarding areas of study, and teaching basic plastic elements, forms, and materials. These assignments, as well as assignments within the advanced workshops (illustrated by Findeli using the Product workshop), were also intended to promote an understanding of the technological and aesthetic principles underlying the artistic structure and how to manipulate these elements.

The philosophy with which design as well as pedagogy was undertaken at the Institute of Design was centered on organic functionalism, which reinterpreted "form follows function" to encourage the reuse of designs found in nature. This philosophy, based on a combination of rational and phenomenological aspects of philosophy from John Dewey and Goethe, also influenced the curriculum by providing an impetus for

[141] Ibid.

study of biological and life sciences, chemistry, physics, and the social sciences integrated with study of the arts.

The curriculum design and underlying pedagogical philosophy that can be seen in the Institute of Design under Moholy-Nagy has its echoes in modern architectural practice. For example, the emphasis on organic functionalism can be seen in various ways, ranging from cybernetics to blob architecture and other organically-focused uses of design. The emphasis on the sciences can also be seen in modern pedagogy, particularly the emphasis on physics and chemistry. These elements of educational philosophy, which integrate both rational and phenomenological aspects, have clearly influenced the practice of architecture. However, Findeli does not carry this historical discussion through to its logical conclusion—the point of understanding how these principles are reflected in (or have been abandoned by) modern architectural pedagogy. This is in part the goal of the current research.

The history of U.S. architectural schools

Architecture School: Three Centuries of Educating Architects in America (ed. Joan Ockman and Rebecca Williamson) provides a comprehensive history of architectural education in the United States, beginning with the colonial period and ending with the present day. The beginning of the architectural trade was based in a loose apprenticeship system (free of the guilds that ruled the Old World), with carpentry and other trades taught for a period of seven years. The first organized effort at centralized education took place in 1724 in Philadelphia when the Carpenters Company was formed to provide instruction in architecture; however, the amount of actual education provided by the company was probably limited given that the company only offered a library for 110 years. In 1754, a school was established in New York, during a period that Ockman describes as bridging a transition between architecture as science or trade and architecture as art. The first university program in architecture, at the University of Virginia (originally the Albemarle Academy), was established in 1814 by Thomas Jefferson.

During the 19th century, similarities to the European traditions of the polytechnic and École des Beaux-Arts emerged.[142] By1894, there was significant conflict between the American system and the dominant beaux-arts structure.[143] Various modernization attempts were undertaken to fix this problem. The first was the 1857 establishment of the American Institute of Architects (AIA), which served as the first American professional architectural body. The second was the passage of the 1862 Morrill Land Grant Act.[144] The Morrill Act enabled states to establish systems of land grant universities, resulting in a dramatic spread of the public university system into rural areas as well as into the "mechanic arts." In response, American architecture programs largely abandoned the beaux-arts structure, which emphasized humanism and aesthetic form, and instead turned to a polytechnic model, with a dominance of technology and engineering over philosophy and aesthetics.

By World War I, these methods of teaching architecture were rapidly being called into question.[145] The Association of Colleges and Schools of Architecture (ACSA),

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[142] Joan Ockman, introduction to *Architecture School: Three Centuries of Educating Architects in North America*, ed. Joan Ockman and Rebecca Williamson (Cambridge, MA: MIT Press, 2012), 12.
[143] Ibid., 16.
[144] Ibid., 16–17.
[145] Ibid., 19–20.

recognizing the need for changes in the curriculum and academic program of its member schools, produced several reports that surveyed the existing curriculum approach. More cuttingly, French architect Le Corbusier "in 1923 advised the readers of his *Vers une architecture* to pay heed to America's engineering achievements but to pass over its architectural ones."[146] Despite this critique, there was already an incipient modernist strain in American architecture, which was promoted by the influence of the Bauhaus in the mid-1920s. Development of new innovative approaches during the 1920s was constrained by the Great Depression, which resulted in a "crisis of confidence" about "whether traditional educational methods were sufficient to equip new architecture graduates to deal with the complexities of modern life."[147] By 1927, the ACSA had begun its reform movement, including standardization of the architectural curriculum across a four-year program, introduction of collaborative programs, and other changes, and Bauhaus design notions had begun to spread to the United States, ending the dominance of the Beaux-Arts model.[148]

The post-World War II period was characterized by an optimistic view of technology and a change in the architecture student body; the education of many students had been interrupted by the draft during World War II, but the GI Bill enabled them to continue their studies, as older students returning home from the war.[149] This resulted in rapid growth in enrollment and the number of architecture program, as well as a different

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[146] Ibid., 20.
[147] Anthony Alofsin, "American Modernism's Challenge to the Beaux-Arts," in *Architecture School: Three Centuries of Educating Architects in North America*, ed. Joan Ockman and Rebecca Williamson (Cambridge, MA: MIT Press, 2012), 95.
[148] Ibid.
[149] Joan Ockman and Avigail Sachs, "Modernism Takes Command," in *Architecture School: Three Centuries of Educating Architects in North America*, ed. Joan Ockman and Rebecca Williamson (Cambridge, MA: MIT Press, 2012), 123.

student body composition. Of particular interest was an emphasis on industrial design (driven in large part by the postwar demand for new homes), which was a focus of the Institute of Design.[150] Collaborations with industry were common during this period, as were partnerships with urban planning and other fields, leading to updated curriculums as well as innovative environmental approaches like systems thinking.[151] Philosophies of architectural space and integration of eclectic knowledge began to become common; to counter that movement, pragmatic programs were developed.[152]

The late 1960s and early 1970s were marked by total elimination of beaux-arts and general systems theory and social awareness.[153] Hands-on learning, collaboration, and non-hierarchical and open evaluation systems (like pass-fail grading) were implemented in order to reduce the strict structure of architectural training.[154] The conflict between the Whites and the Grays[155] introduced conflict into the formal experimentation question, leading to a number of interesting innovations such as the collage and Cubism-inspired compositional exercises.[156] The 1970s saw a renewed

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[150] Ibid., 129.
[151] Ibid., 130, 141–146.
[152] Ibid., 138–139.
[153] Mary McLeod, "The End of Innocence: From Political Activism to Postmodrnism," in *Architecture School: Three Centuries of Educating Architects in North America*, ed. Joan Ockman and Rebecca Williamson (Cambridge, MA: MIT Press, 2012), 164–165.
[154] Ibid., 167–168.
[155] According to the author, the Whites and the Grays represented two distinct approaches to architectural pedagogy and formal experimentation in the postmodern era. The Greys, led by Robert Venturi, rejected modernism's spare and undecorated approach, arguing instead for complexity and ambiguity within the architectural form. The Whites, led by Peter Eisenmann, were more concerned with issues of language, semiotics, and meaning, following other postmodern philosophers such as Mikhail Bakhtin and Jacques Derrida. In a nutshell, the Greys argued for the primacy of form in the architectural object, while the Whites argued for primacy of semiotics. A full discussion of the White/Grey debate is outside the scope of this writing, but it does represent one of the most interesting aspects of postmodern influence on the architectural pedagogy.
[156] Ibid., 174–177.

interest in aesthetic and form, including techniques of the early modernists, as well as architectural history.

Postmodern architecture was characterized by "historical quotations"[157] that served to reference the past. Recent development of pedagogy focuses on design technologies, as well as a change in theoretical direction for American architects.[158] Computers were not generally used before 1990 in the design studio, but became more common over the 1990s and are ubiquitous today.[159] As students gradually transitioned to "digital natives" (those who have used digital technology throughout their entire lives) the use of computers as a tool for design has become unremarkable too.[160]

Current Theory and Practice of the Use of Technology in Architecture

Architecture and the machine

The philosophy of the architectural object as a machine emerged during the modern period and continues to inform architecture today. It is based on the development of mass production and mechanical interventions combined with the rise of a relationship between art and the class struggle that was extant in Europe in the early part of the 20th

[157] Ibid., 188.
[158] Stan Allan, "The Future That is Now," in *Architecture School: Three Centuries of Educating Architects in North America*, ed. Joan Ockman and Rebecca Williamson (Cambridge, MA: MIT Press, 2012), 210.
[159] Ibid., 214–215.
[160] Ibid., 216.

century.[161] This historical context is described above in the discussion of the Vkhutemas and Bauhaus schools of the 1920s and 1930s.

In particular, the aesthetic of the machine emerged from the development of bourgeois art and the evolution of an understanding of art including the culture industry and autonomous art. "In the former, culture is mass-produced in the pursuit of profits and thus must cater to mass tastes. In doing so, it abandons the utopian function found in autonomous art—holding out the promise of a better world, while simultaneously revealing the antagonisms of the existing society that prevent this world from being realized."[162] These two conflicting visions were formed based on the class structures of Europe during the 1910s and 1920s and on the development of mass production. However, as Gartman notes, it was only possible in Europe for the conflict between the culture industry and autonomous art to result in modern architectural norms. In America, where capitalism reigned supreme, the role of the culture industry proved to be overriding.[163]

This conflict in Europe led to the development of a machine aesthetic, initially formulated as "new objectivity" by architects including Mies van der Rohe and Walter Gropius.[164] The resulting style "was generally characterized by simple, undecorated geometric forms, usually of severe rectilinearity, constructed of industrially produced building materials like steel, glass, and concrete."[165] These forms were intended to take advantage of the functional elements of mass production, and by appropriation of the

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[161] David Gartman, "Why Modern Architecture Emerged in Europe, not America: The New Class and the Aesthetics of Technocracy," *Theory, Culture and Society* 17, no. 5 (2000): 76.
[162] Ibid., 77.
[163] Ibid., 78.
[164] Ibid., 87.
[165] Ibid.

forms of the culture industry for an autonomous artistic purpose, they resolved the conflicting demands of art as industry and as individual expression. This attempt at purification also had its origins in the development of the Taylorian approach to scientific management, which further enforced the idea of the human space as one intended for rational and scientific movement.[166] This involvement with scientific management theory also affected the role of engineering in modern architecture since the engineering and artistic aspects evolved in concert with each other.

The development of the machine aesthetic was not just an artistic statement regarding involvement in the machine; the architectural object itself was characterized as pure, rationalized, and machine-constructed. In fact, over time the notion of the machine aesthetic began to change from an understanding of the architectural object as facilitated by mechanization to an understanding of the architectural object as a machine in and of itself.[167]

The machine began to be regarded as the ideal for the architectural object with the differentiation between natural and functional aesthetics in the Enlightenment writings of Lord Kames and Francis Hutcheson in the 18th century.[168] The rationalist and functionalist theorists of the 19th century further developed this differentiation. They saw in the machine and its functional nature the key to development of a purely functional, and thus modern, form of architecture. The philosophical grounding of Descartes, who created a mechanistic form of relationship between the human body and its thought

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166 Mauro F. Guillén, "Scientific Management's Lost Aesthetic: Architecture, Organization, and the Taylorized Beauty of the Mechanical," *Administrative Science Quarterly* 42, no. 4 (1997): 683.
167 Gartman, "Why Modern Architecture Emerged," 87–90.
168 Phillip Steadman, *The Evolution of Designs: Biological Analogy in Architecture and the Applied Arts* (New York: Taylor & Francis, 2008), 10.

processes, provided support for development of this so-called mechanical analogy.[169] The functionalist view, it should be noted, is not a value-free model of understanding architecture. Instead, “there is frequently a moral attitude underlying the functionalist view as a whole. No part of the work should be dispensable, unnecessary to the general aim. Every part should have a meaning . . . should play its part.”[170] Thus, understanding the concept of the architectural object as a machine is contingent upon understanding the role of the industrial revolution and its impact upon the formation of functionalist aesthetics.

Digital technology and architecture

The practice of digital architecture is a relatively recent development in the field and has emerged as complementary to or, in some cases, as a replacement for traditional architectural techniques. Although methods such as parametric modeling have been used for some time and have emerged from the development of computer-aided drafting (CAD) and design during the 1980s, other digital methods are far newer and are often derived from other areas of information theory. Currently, digital architecture is, in many of its guises, less than a decade old. Its varied methods, derived from mathematics, computer science, and biology as well as other scientific fields, have not yet firmly settled into the framework of traditional architectural methods. However, neither has digital architecture coalesced into its own independent field. Digital architecture as a field can best be characterized as rapidly evolving, coalescent, and fragmented.

[169] Ibid., 10–11.
[170] Ibid. 4.

Despite this lack of cohesion within digital architecture, there is evidence that it has been enthusiastically adopted in the pedagogy of leading schools of architecture. This adoption involves the teaching of, and experimentation with, fields of digital architecture in a manner that is complementary to the traditional techniques of architecture. This integration includes methods like parametric modeling, which are by now a well-founded and robust area of architectural practice. However, it also includes much newer methods, such as iterative or indexical architecture and biomimetic architecture, which in some cases are so experimental that they have not yet been fully implemented into active practice.

This implementation of highly experimental methods is not unique to the contemporary period. The foundational schools of modern architecture and design, the Bauhaus (located in Weimar, Dessau, Berlin, and then Chicago) and Vkhutemas (located in Moscow) also reacted to changes in available technology and intentions and use of architectural design with direct implementation into pedagogy rather than waiting for these methods to become established practice in the post-educational field.The similarity in adoption of materials management techniques and pedagogy, in particular, between the modern schools of digital architecture and the Vkhutemas and Bauhaus schools, which emerged at the beginning of the industrial age, provides a point of comparison of pedagogies, as well as a means of understanding the historical context of the architectural pedagogical approach in use today. By comparison between modern premiere architectural schools and those of the 1920s, this research strives to illuminate of the integration of technologies in architectural history and current practice.

Digital architecture: Tool and philosophy

Digital design refers to the process of design, rather than the output of the architectural process.[171] Digital is defined by Terzidis as "reduction of a process into discrete patterns and the articulation of these patterns into new entities to be used by a computer."[172] However, this definition is not sufficient for understanding the impact of digital architecture on the architectural pedagogy.

Digital architecture is an amorphous concept that can refer to either a mode of architectural design or production (simply that of using a computer, such as CAD/CAM and parametric modeling), or to a shifting paradigm of architecture in which the architectural object is viewed as an organism or a proto-organism, rather than as a machine under the modern architectural model. Many of the processes of digital architecture either represent simple digitization of traditional manual design techniques or an excessive focus on marketing rather than substance. The output is consistent with the product of traditional architectural production techniques, while other technological or digital products are substantially different.[173] However, there is some overlap in these methods; for example, CAD/CAM may be used either with traditional models of modern architecture, in which the architectural object is understood as a space and as a machine, or with the advanced model of digital architecture, in which it is considered to be an organism or proto-organism.

[171] Kostas Terzidis, *Algorithmic Architecture* (Oxford: Architectural Press, 2006), 40.
[172] Ibid., 39.
[173] Ibid.

Digital architecture as a tool

Digital architecture as a tool is primarily based on the understanding of the architectural object as a system (which could be either a machine or an organism). Systems theory "argues that the concepts and principles of organization in natural systems are independent of the domain of any one particular system."[174] The system has a number of characteristics in systems theory, including that:

- The system has properties distinct from the properties of its parts.[175]
- The system is self-organized, and systematic properties do not survive destruction of the components.
- Systems exist at multiple levels, which are self-similar but have unique characteristics.[176] (This self-similarity, combined with self-organization, indicates emergence.)
- Systems are heterogeneous.[177]

The networked nature and emergent characteristics of systems imply that the appropriate architectural design principle is that of algotechture, or implementation of algorithms for design.[178] This can be done using computational techniques (such as CAD) or biological or mathematical algorithmic approaches. The algorithm does not solve the problem directly, but instead offers the human designer insight into how a problem *could* be

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[174] Michael Hensel, Achim Menges, and Michael Weinstock, eds., *Emergence: Morphogenetic Design Strategies* (New York: Wiley, 2004), 15.
[175] Fritjof Capra, *The Web of Life: A New Scientific Understanding of Living Systems* (New York: Anchor Books, 1997), 36.
[176] Ibid., 37.
[177] Ibid., 38.
[178] Terzidis, *Algorithmic Architecture*, 37.

solved.[179] The final selection of a solution is dependent on choices made by the designer. In particular, while algorithmic approaches can provide satisfactory technical solutions, the human designer must direct the selection of aesthetics and form.[180]

The most common approach to architecture as a tool using systems theory is parametric modeling, the use of computational modeling in order to create architectural designs.[181] Parametric modeling is a process in which the initial design features are established and are then iterated algorithmically by a computer program using integrative calculus to take into account issues such as ground movement and tectonics, physical conditions, gravity, and other elements of movement, time, and space.[182] In effect, parametric modeling is an approach that formalizes the so-called ethics of motion and introduces the features of actual motion into the design. Parametric modeling does not, however, allow for independent creation of form; instead, it offers a limited set of changes that allows the human designer to select from a larger set of possibilities than would be reasonable to generate by hand.[183] Control of the design remains entirely with the human designer; thus, parametric modeling is only a tool onto which the designer projects his or her own philosophy.

The main tools of parametric design are topology, time, and parameters. Topology is the creation of a flowing surface, rather than a static face as used in traditional designs.[184] The topological surface is comprised of a series of splines or directional vectors that allows for the creation of curved surfaces using U and V orientations. The

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[179] Ibid., 38.
[180] Ibid.
[181] Greg Lynn, *Animate Form* (Princeton: Princeton Architectural Press, 1999), 15.
[182] Ibid.
[183] Ibid., 19.
[184] Ibid.

splines permit weight and gravity to be taken into account and facilitate arrangement of tension along the surface hulls. In addition to the X, Y, and Z Cartesian coordinate space, splines are also defined by a temporal element, in which differential equations are used in a combinatorial approach in order to transform the spline vectors.[185] This also allows for a definition of motion due to the construction of the spline as a vector rather than a point.

Keyframing, a process of creating infinitely small snapshots of the movement produced by the set of splines, facilitates modeling of movement and force within this structure. Linear and nonlinear changes can then be produced through the process of morphing (changes in linear structure) and dynamics (changes in motion structure). Topologies create landscapes, in which splines create structures that do not allow for identification of the locality of a point shift.[186] Topological landscapes can include "isomorphic polysurfaces (or blobs), skeletons (or inverse kinematics networks), warps, forces, or particles."[187] Keyframing is performed by using calculus to create infinitely small changes in the topological landscape.[188]

Parameters, or specifications of the conditions under which the architectural object being designed will be used, are also useful within this representation.[189] Parameters are defined in continuous or iterative series of calculations, in which certain elements are either added or removed in order to determine the outcomes, which are iteratively based on previous outcomes. Changes may be in aesthetics, but are more

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[185] Ibid., 21.
[186] Ibid., 29.
[187] Ibid., 30.
[188] Ibid., 15.
[189] Ibid., 33.

commonly performance-oriented. The human designer then makes adjustments to balance aesthetic and performance goals.[190]

Tessellation is commonly used in parametric design.[191] Tessellation can be defined as "a collection of pieces that fit together without gaps to form a plane or surface.[192] It is primarily a decoration technique, using hand-assembled tessellated patterns (such as in mosaics) in order to achieve a complex and detailed design. In parametric design, tessellation allows for construction of curved surfaces using approximating techniques that model a smoothly curved surface. The introduction of fluid dynamics to tessellation results in discretization, or "the digital definition of surface as a set of coordinated parts."[193] Discretization creates surfaces not as a static geometric form but as a shifting surface. One form of discretization is structuring, which is "the process whereby the logic of a unique parts-to-whole relationship develops between the elements of architecture."[194] This results in a digital tectonic, which represents the shift in the design from initial state to completed state. This process has emerged only within the past five years and is therefore a very new tool in the digital architecture paradigm.

Examples of tessellation in materials fabrication include tessellated wall units constructed by robots driven by computerized construction plans, which allow for high-speed and accurate assembly of complex designs.[195] Materials that have been applied to tessellation include plastics, polycarbonate foam, wood, glass, and cement. Airspace

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[190] Ibid., 32.
[191] Branko Kolarevic and Kevin R. Klinger, *Manufacuturing Material Effects: Rethinking Design and Making in Architecture* (New York: Routledge, 2008), 13.
[192] Lisa Iwamoto, *Digital fabrications: Architectural and material techniques* (Princeton: Princeton Architectural Press, 2009), 36.
[193] Ibid., 37.
[194] Rivka Oxman and Robert Oxman, "New Structuralism: Design, Engineering and Architectural Technologies," *Architectural Design* 80, no. 4 (2010): 17.
[195] Iwamoto, *Digital Fabrications*, 39.

Tokyo, a metallic open-cell cladding for an existing building, and Helios House, a conceptual green gas station, both demonstrate the use of tessellation in materials fabrication and design.[196] The practice of tessellation—here, the specific measurements and adjustments are performed by computational power, but the design in which the tiles will be arranged is chosen by a human designer—clearly illustrates the notion of digital architecture as a tool to be employed in conjunction with the designer's philosophies, but which are not restrictive to any particular philosophical notion.

Digital architecture as philosophy

Digital architecture as a philosophy rather than as a tool is founded upon the idea of emergence, an evolutionary process in which the understanding of the evolution of natural systems is applied to that of artificial systems.[197] Emergence relies on the outcomes of coordinated group behavior in order to effect changes within the environment.[198] This concept came from the modeling of slime mold behaviors; slime molds are comprised of single-cell organisms that work in concert in order to act on their environment through movement, but this concerted effort is driven at the single cell level, rather than externally imposed.[199] Other examples of emergence include the structures of the ant colony and the human body. Research on emergence first focused on complexity,

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[196] Ibid., 50.
[197] Hensel, Menges, and Weinstock, *Emergence*, 6.
[198] Stephen Johnson, *Emergence: The Connected Lives of Ants, Brains, Cities and Software* (New York: Simon and Schuster, 2002), 13.
[199] Ibid., 16.

then on function; recently, studies have turned to understanding how complexity can be developed, rather than simply observed.[200] Characteristics of emergent systems include:

- Simplicity of organization and communication,
- Randomness and decentralization,
- Pattern matching characteristics that allow for communication and identification of external conditions, and
- Local actions based on the actions of neighbors.[201]

Emergence in digital architecture is an expansion of the idea of form finding, which was used in physical form by Antoni Gaudi and Otto Frei.[202] The specifics of this form finding process, or morphogenesis, vary; it can be performed mathematically, using network modeling, or using genetic algorithms to evolve an end-state design out of initial conditions and applied environmental changes.[203] Function is also addressed within morphogenesis, with specific materials being selected during the evolutionary process in order to meet the requirements of the design.[204]

One of the core ways in which a difference in architectural philosophies may be expressed is in the selection and use of materials and fabrication. Traditional materials use in architecture, as discussed above, developed—in the pedagogy of the Bauhaus and Vkhutemas—into the use of constructivist thought. This was the first time that the materials in use in the architectural construction became relevant for physical characteristics rather than simply aesthetics or availability.

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[200] Ibid., 21.
[201] Ibid., 78–79.
[202] Hensel, Menges, and Weinstock, *Emergence*, 8.
[203] Ibid., 7.
[204] Ibid.

The advent of digital design, particularly computer-aided manufacturing (CAM), has positioned composite materials, which are explicitly designed for their functional characteristics, to the forefront of architecture regardless of the exact nature of the architectural object.[205] The value of composite materials can be seen as follows:

> [Composite materials] offer the unprecedented capability to directly formulate material properties and effects by digitally controlling the production of the material itself. The composition of such materials can be engineered precisely to meet specific performance criteria, so that properties can vary across the section to achieve, for example, a different structural capacity in relationship to local stress conditions, or variable fiber density to achieve different opacity and appearance. By manipulating material variables in composites for local performance criteria, entirely new material, tectonic, and ornamental possibilities open up for architecture. Furthermore, wiring, plumbing, and mechanical systems can be embedded into layers of the composited material.[206]

Of course, the extent to which these characteristics of the composite *are* taken advantage of is debatable. One value of using composite materials is the ability to manufacture material effects, or effects required for the design, specifically and in a single component; otherwise, the design must be compromised, or multiple materials have to be manipulated in order to achieve the same effect.[207]

Computer-aided design (CAD) and computer-aided manufacturing (CAM) influence materials selection and fabrication in both traditional approaches to architecture and digital architecture.[208] Traditional materials such as wood, glass, and stone continue to be employed, although often in different ways due to the fine control of the fabrication process made possible through digitalization.[209] For example, translucent concrete and

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[205] Kolarevic and Klinger, *Manufacuturing Material Effects,* 6.
[206] Ibid.
[207] Ibid., 7.
[208] Hensel, Menges, and Weinstock, *Emergence*, 37.
[209] Ibid.

curved aluminum stress skins are traditional materials that lend themselves to new applications both aesthetically and in terms of their physical characteristics.[210] However, these techniques are agnostic in terms of their philosophical approach and, as such, are not indicative of the underlying philosophy of the user; while these are computer-based or digital tools, they do not necessarily signify a unified digital architecture philosophy.

There are a number of different kinds of technologies that are used in the teaching of architecture, but the main emphasis in this research is *information technology* (IT), or computational methods of manipulating information. Some of these technologies, such as 3D printing and other information-based fabrication techniques, do have tangible effects, such as new materials or models. Most use of digital technology in architecture is based in CAD. Yet more complex uses are possible.

The digital narrative in architecture is overwhelmingly one of unity contrasted with multiplicity of other communities, but it has the potential to fragment into many different communities.[211] Some of these discourses of fragmentation include the digital divide, the problem of alienation of technology, and problems of status quo and growing inequality.[212] Coyne connects the digital narrative with the Romantics of the 18th and 19th century, who rejected the rationalist demands of Descartes and others and repositioned emotion and intuition as the core of the human experience.[213] There is also a rationalist component to the digital narrative derived from notions such as Descartes' autonomous

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[210] Kolarevic and Klinger, *Manufacuturing Material Effects,* 8.
[211] Richard Coyne, *Technoromanticism: Digital Narrative, Holism and the Romance of the Real* (Cambridge, MA: MIT Press), 4–5.
[212] Ibid., 5.
[213] Ibid., 5–6.

subject.[214] Coyne argues that the rationalist component of the digital narrative receives the most attention, although the Romantic component is clearly dominant.

Coyne notes that IT helps people transcend their physical existence into a "digital utopia"[215] while at the same time returning to a pre-industrial world of connection and locality (the "digital cottage"). This, as Coyne notes, is a purely romantic narrative, rather than a rational narrative in any sense. At the same time, however, multiplicity can be seen in the discourse of realism, especially in empirical and logical studies of IT that impose order and rationality.[216] This leads to the fracturing of narratives and the emergence of multiple views of IT and cyberspace that cannot necessarily be reconciled.[217] The narrative of digital utopia is forward-looking and unifying, and it promotes technology as a means of progress and removal of social barriers to equality.[218] The digital utopia serves several purposes, including promoting a more positive future and reinforcing the theme of equality that it is meant to serve.[219] This effect may be limited, however; Coyne argues that potential change may be confused with actual change, reducing the power of this narrative. Counter-narratives, such as rationalist narratives, critique the digital utopia on various fronts, including its contradictory and ephemeral nature, and they reject the "notion of free property,"[220] which is a foundation of the utopian discourse.

Cyberspace extends beyond the digital utopia, and Coyne proposes that "the computer age will eventually see a transformation . . . in which the physical is

[214] Ibid., 7.
[215] Ibid., 9.
[216] Ibid., 10–12.
[217] Ibid., 12.
[218] Ibid., 19.
[219] Ibid., 20.
[220] Ibid., 44.

transcended by information"[221] and unity results, enabling every person to participate equally in a networked world. This is presented as a form of *reality*—virtual reality—which adds another dimension to the narrative of the digital utopia. The notion of the real inherent in cyberspace, which Coyne likens to the reality of *Alice in Wonderland*, has various identifiable characteristics, including proximity, repetitiveness, ineffability, sharing, and the body.[222] These characteristics act as criteria for determining what is real and what is not real; virtual reality, according to Coyne, seeks to replicate this experience without its usual physical groundings. Coyne argues that the technoromantic dialogue of cyberspace draws on a similar notion of reality as Plato's cave, where reality can be seen only as shadows reflected on the wall.[223] However, he also sees parallels to Hegel's dialectic of being and nothingness, with reality being a center ground between unity (romanticism) and multiplicity (rationalism).[224] Thus, the narrative of cyberspace is largely Neo-Platonist.[225]

The Digital / Technology Argument

This section critiques and questions a selection of the theoretical literature that addresses the position of technology in society and in the classroom. The main point of this chapter is to examine critiques of technology and refute the notion that architecture (or any other facet of human experience) is technologically determined. Issues like the

[221] Ibid., 47.
[222] Ibid., 48.
[223] Ibid., 50.
[224] Ibid., 52.
[225] Ibid., 55.

role of technology in modernity, the meaning of multidisciplinarity, the relationship between man and environment, and the uses and limits of digital architecture serve to demonstrate how technology needs to be contextualized and positioned within the human experience and why this contextualization is necessary for a proper critique of its role.

Andrew Feenberg observes that technological change is not isolated, but instead echoes through society at multiple levels (including social, political, and economic).[226] He argues that modern societies remain in enthralled with technology as an alien, outside force that is imposed on society, rather than something it creates for itself.[227] Social inquiry continues to use a form of technological essentialism, where efficiency and technological practices, rather than human practices, are considered to be dominant, and technology is separate from social values and philosophies. However, Feenberg rejects this approach on the principle that attempting to encapsulate technology eliminates all potential for dealing with its influence on society.

Feenberg demonstrates the problems of existing approaches to technology using the house, noting that the house can be viewed as an essentially technological object, or rather series of objects (technological house systems).[228] The house is simultaneously part of the individual's lifeworld and exists in a social and historical context that changes the technology that is implemented within it. Thus, a non-essentialist approach must be used to understand technology and its embeddedness in society.[229] Rather than using a dichotomous approach to understanding technology and meaning, he views technology as

[226] Andrew Feenberg, *Questioning Technology* (Florence, KY: Routledge, 1999), vii.
[227] Ibid., viii.
[228] Ibid., x–xi.
[229] Ibid., xiii.

"a terrain of struggle between different types of actors differently engaged with technology and meaning."[230]

Another point of Feenberg's discussion is the view of technology in social thought. He notes that the traditional views, such as determinism and humanism, are neutral, being used as a means but not changing the ends of social development or change.[231] In contrast, technocratic theories hold that technology is fully determinant of social development and change. The substantivist view (as championed by Heidegger) rejects both of these views, instead holding that technology is part of an integrated world and serves to illuminate the characteristics and elements of this world.[232]

Feenberg also outlines two other philosophies that have influenced the study of technology: left dystopianism and social constructivism. In left dystopian, technology builds political power, but is also dependent on political power, suggesting that technological elites must bow to the democratic will of the public.[233] Social constructivism carries forward some of the critiques of left dystopianism, including "the link between means and ends and contingent development."[234] The two philosophies differ in that constructivism uses a dual focus on the social processes and technological developments and positions technology as a social force (like institutions).[235] In postmodernism, epistemological relativism has been adopted as a means of reconciling differences in viewpoints and the problem of multiculturalism.[236]

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230 Ibid.
231 Ibid., 2.
232 Ibid., 3.
233 Ibid., 8.
234 Ibid., 10.
235 Ibid., 11.
236 Ibid., 14.

Feenberg's summary of the positions of various philosophies of technology is shown in the chart below.

Technology is:	**Autonomous**	**Humanly Controlled**
Neutral (complete separation of means and ends)	Determinism (e.g. traditional Marxism)	Instrumentalism (liberal faith in progress)
Value-laden (means form a way of life that includes ends)	Substantivism (means and ends linked in systems)	Critical Theory (choice of alternative means-ends systems)

Figure 2. Summary of positions regarding technology.[237]

Feenberg presents his own theory of the development of technology, taking into account these differences. He also reflects on the role of the technical expert in the selection of technology and its use.[238] He notes that the technical experts, who make the majority of decisions regarding the development and use of technology, are inherently undemocratic; they are granted power by administrative procedures and education, rather than being elected or otherwise selected by consensus. At the same time, however, the technical expert may claim to be a representative of the people and that decisions are made based on this feeling.

[237] Ibid., 9.
[238] Ibid., 137.

Feenberg's concretizing theory, which he poses as a means of explaining why the role of technology often goes unremarked in social analyses, is of particular interest.[239] This theory, based on previous work by Simondsen, Ihde, and others, suggests that the role of technology can no longer be seen once it is internalized. Instead, technologies are viewed as a mere channel or medium for the lens of external social influences. In effect, the concretization of technology is a "technological unconscious"[240] in which technology is never consciously understood to be an actor or social force. This theory reinforces the understanding of technology and its use as a phenomenon that must be questioned, rather than something that is simply accepted without analysis or critique.

What Feenberg and others do not directly discuss is the idea of *what* technology is. Is technology a process, a concept, a tool, or an affordance? This question is left unexplored, and thus the nature of technology is left unremarked and unrefined. This does not offer space for theorizing about how technology fits into the material world of the architect, even though the more abstract notion of technology as an undefined phenomenon is suitable for understanding its role in the cognitive and visionary world.

This gap could be partially filled by understanding the technology as an object or a succession of objects, although this is also problematic in that it does not provide the means of understanding technology as a process. The notion of the, however, does suffice to understand the products that exist due to the use of technology.

In *Design and Environment; or, The Inflationary Curve of Political Economy*, Jean Baudrillard explores the notion of the object. He states that the emergence of the object as a class of goods can be dated to the Bauhaus and argues that the Bauhaus

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[239] Ibid., 218–220.
[240] Ibid., 220.

school's use of design rationales and synthesis of form and function (including social and symbolic forms as well as physical forms) represents the first truly rational approach to design as a process. [241] This was neither a revolutionary nor a utopian state; instead, it represented a theoretical extension of existing political economy and semiotic and object systems. The emergence of the object (including separation of man from environment, division of labor of objects, and semiological articulation of the object) is an essential element of the emergence of this type of study.[242] Design then involves rational abstraction, regardless of whether *design* is understood to be artistic design, planning, or drawing (the three possibilities Baudrillard considers).[243]

In *The Proairetic Factor*, Gillo Dorfles discusses the role of design within education. Dorfles sees the first task of design as "establish[ing] the limitations and the values of the artificial and the natural"[244] in order to integrate them better. Dorfles argues that the relationship between man and his environment, and the social and psychological aspects of this relationship, should be design priorities rather than other elements; however, he argues that many aspects of this relationship, such as the micro-milieu and the relationship between territory and inhabitant and semanticization of the habitat, have been under-examined compared to other aspects of this relationship, such as physiology and technology.

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[241] Jean Baudrillard, "Design and Environment: Or, the Inflationary Curve of Political Economy," in *The Universitas Project: Solutions for a Post-Technological Society*, ed. Emilio Ambasz, et al. (New York: Museum of Modern Art, 2006), 50–51.
[242] Ibid., 52–53.
[243] Ibid., 54.
[244] Gillo Dorfles, "The Proairetic Factor and the Concept of Asymmetry in Design," in *The Universitas Project: Solutions for a Post-Technological Society*, ed. Emilio Ambasz, et al. (New York: Museum of Modern Art, 2006), 80.

To meet these ends, Dorfles discusses seven priorities in the study and design of environments and habitats.[245] These include establishing points of reference in the built environment and creation of a symbology, a "recuperation of the natural" to enable connection to nature, stimulation of sensitivity to discordant design, rejection of "art containers" (such as museums) in favor of aesthetic environments, and establishment of a pragmatic element of architecture in addition to the current semantic and syntactic dimension. These tasks are intended to recreate a connection between man and the environment that was severed by the separation inherent in modernity.

In *Digital Culture in Architecture*, Anthony Picon observes that, at this point, the question is not whether integrating digital technologies into architectural practice is a positive or negative thing; it is a fait accompli.[246] Instead, he argues, the focus should be on *how* digital technologies are used in architecture and "what direction architecture is taking under its influence." He notes that it was not only technological change that drove the evolution of architectural practice; there were other, equally important factors as well, such as the emergence of architectural postmodernism.[247]

In *The Limits of Digital Architecture*, David Theodore takes a critical view of the notion of digital architecture, noting that in many cases what is meant by "digital" means simply working with data—not undertaking any form of digital revolution.[248] Perhaps more importantly, he questions whether there is a meaningful distinction to be made between digital design and digital architecture, and if so what that meaning might be. He

[245] Ibid., 80–82.
[246] Antoine Picon, *Digital Culture in Architecture* (Berlin: Birkhauser, 2010), 8.
[247] Ibid., 9.
[248] David Theodore, "The Limits of Digital Architecture: Interpretation versus Data," in *Acadia 2010: Life in:formation* (New York: Association for Computer Aided Design in Architecture, 2010): 293.

offers three possible ways of moving toward a differentiation, although he concludes in the end that there is still no clear distinction to be found between the various types of activities that may be described as digital and what (if any) role remains for architecture as traditionally defined.[249] Theodore argues that architecture is not simply book knowledge, but is instead an embodied skill (or techné). This argument suggests that students learning line drawing techniques and students learning CAD are not learning the same discipline. Although the end result of architectural objects may be the same, the use of data-driven tools to generate these architectural objects is in a real sense not the same task. Theodore concedes that this is not a particularly convincing argument; it is only used as an entry point into imagining how a digital architecture could be defined.

A second and perhaps more compelling argument is that architecture is, at least in part, an interpretive process.[250] That is, the role of the architect is not just in performing calculations and accommodating technical requirements; it is in interpreting social, cultural, aesthetic, and other values and understanding what this means for human comfort regarding a particular form of built environment. Thus, even when using digital design techniques, it is not possible to fully parameterize factors such as comfort or pleasure in a given environment. The architect, who still must use her human faculties, is not yet a digital architect, even if she is a digital designer.

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[249] Ibid., 296.
[250] Ibid., 294–295.

Current Issues in Architecture

The two previous sections within this chapter have provided a comprehensive introduction to the technologies and theories that form a foundation for uses of technology in architecture. In this section, attention turns to the current issues and debates within architectural practice. The chapter begins with a key question: What is the role of technology in the architectural practice—just a tool or instrumentality, or does it extend into the creative process itself? A second key issue that is explored within this section is the current and previous understanding of the nature of space (especially heterogeneous space) in architecture. By extension of the consideration of space, time also becomes important within this discussion. A further issue, which is explored in detail by Christopher Hight, is the association between the architectural form, the self, and the body. A final subject within this chapter is how to understand the continuity of architectural knowledge over time.

In the Foreword to *Algorithmic Architecture,* Antoine Picon states that there are two major perspectives to the use of computers within architecture.[251] The first of these perspectives regards computers as a tool intended to support human creative endeavors. The second holds that computers themselves are part of the creative process and should be used as such. The perspective of the book is that “design is not properly an invention, the creation of something absolutely new. It should rather be considered as the result of an unveiling or discovery process.”[252]

[251] Terzidis, *Algorithmic Architecture,* vii–viii.
[252] Ibid., viii.

This perspective is highlighted by Terzidis, who discusses the difference between computerization (the use of the computer as a rational tool to leverage human creative activity through calculation and automation) and computation (the use of the computer as a tool to generate knowledge).[253] Terzidis notes that computerization is the most common mode of computer utilization, even among architects (such as blob architects) who use them heavily; their goal is not to generate new designs from within the computer, but instead to materialize the design already identified within the architect's mind. The use of computers for computation, in which something new that had not been imagined previously by the architect emerges, is much rarer.

Despite the potential power of computers, Terzidis states that the problem space of design[254] is still too large, even when using computers for calculation, to logically identify an optimal design choice out of several. Approaches like structural linguistics and heuristics were required to reduce the problem space accordingly. Terzidis argues that, in most cases, the use of computers in the design process does not meet these requirements, even today, and logic and intuition remain largely divorced. In contrast, techniques such as CAD, which are designed to manipulate numbers and produce ideal designs when guided by human input, are heavily implemented.[255] The end result is that,

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253 Ibid., xi.

254 Terzidis informally defines and discusses the problem space of design as including all potential design choices that could be made by the architect and the calculation of their effects. This is consistent with a parametric view of design, which is based on the formulation, calculation, and manipulation of parameters that change the visual or functional characteristics of the architectural object. In a sense, however, Terzidis is not referring to the calculability of these design changes, but their incommensurability with what we understand as design. Simply, while machine calculation can determine whether an object is physically stable (and to some extent can determine whether it can be built), it is still considered necessary for human judgment to inject concerns of aesthetics and form – the computer cannot calculate whether an architectural object will be beautiful, and thus there is still a role for the human in the design.

255 Ibid., 54.

in most cases, it is still the human who designs and the computer that adjusts and calculates, rather than the computer offering design assistance to the human.[256]

This suggests that understanding technology solely as a human-independent process (rather than an object, as discussed above in the work of Baudrillard and others) is also insufficient. The insufficiency in this case comes from understanding how humans play a role in technology and in architecture and how technology produces affordances for humans in the environment. The discussion of the human's role in the cognition of the architectural process does not take into account the individual's role in the eventual outcome of product or form. Because the human form has an explicit position within modern architecture, looking at the placement of human form in the technologically informed modern architectural object is one way that this difficulty can be resolved, although this approach is not without its own complications.

In his book, *Architectural Principles in the Age of Cybernetics,* Christopher Hight discusses the reintroduction of the human form into architecture in the mid-20th century and its relation to the development of "post-humanism, digital technology, globalization, and science."[257] He argues that the relationship between the body and the architectural form remained more or less stable until the challenges of modern post-humanism. Contemporary theorists have said of technology and architecture that "we are experiencing a quantum leap in the dislocation of the subject due to the internet, virtual realities, and digital visualization."[258]

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[256] Ibid., 60.
[257] Christopher Hight, *Architectural Principles in the Age of Cybernetics* (New York: Routledge, 2008), 6.
[258] Ibid., 8.

Heidegger's 1969 announcement of the "completion of the age of humanist metaphysics"[259] through cybernetics did not stop the flow of change and disruption. Instead, new debates have emerged about the role of the body and its position in the social realm and the relationship between bodies and social forms and structures. The integration of these debates into the architectural field, Hight argues, questions the architect's role as "author"[260] of the architectural object and suggests an intellectual merger between architect and computer.

Hight identifies the body as a distinguishing idea between post-structuralists and phenomenologists.[261] Phenomenologists hope to maintain or recover the connection between the ideal Vitruvian body and the architectural object; post-structuralists use the Vitruvian body as a means of identifying future forms that are no longer based in this norm. This point is illuminated through discussion of Joseph Rykwert's work, in which the body of man is taken as a form of ideal natural architecture.[262] Hight sees a similar representation of architecture's origins and its representation of the body in the works of Alberto Perez-Gomez.[263] Following this, Hight suggests that *humanity* is a pre-requisite and part of the definition for *creation of architecture;*[264] if a given structure is architecture, then its creator is by default human.

Since classical architecture is marked by its relation of man and architectural object, modern architecture must be marked by the decay of that relation.[265] The elimination of decoration is seen as the height of this decay. Hight uses three case

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[259] Ibid., 10.
[260] Ibid., 12.
[261] Ibid., 17.
[262] Ibid., 18–20.
[263] Ibid., 21.
[264] Ibid., 22.
[265] Ibid.

studies—Diana Agrest and her discussion of gender and the architectural subject, Greg Lynn and form, and Peter Eisenman's discussion of historicity and humanism—to demonstrate the relationship of both post-structuralists and phenomenologists with the classical forms of architectural knowledge.[266] What these examples highlight is the *continuity* of architectural knowledge and philosophy through the humanist period (from the 15th century onward).

He also examines the intellectual exchange between Siegfried Giedion and Ernest Cassirer in regard to discussion of proportion and measure during the period of interest.[267] Giedion's 1947 work *Mechanization Takes Command* presents an "anonymous history"[268] of the modern era, especially focusing on the development of various forms of mechanization and their impact on everyday life, art, and other areas. This work was particularly important in forming ideas about measurement and scale. Giedion's arguments within this book focus on a number of themes, including a dominance of "Meat" and "Death."[269] This had a direct impact on architectural pedagogy given that Giedion was at the time teaching at Harvard and Zurich and giving lectures that were distributed in various forms around the world; his ideas, lectures, and writings permeated the architectural pedagogy of the early 1960s and resulted in a return (or at least attempted return) to human scale.[270]

Finally, Hight points to a simple problem in the discourse surrounding the development of modern architecture. If both post-structuralists and phenomenologists

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266 Ibid., 36.
267 Ibid., 113.
268 Ibid., 114.
269 Ibid., 116.
270 Ibid., 118.

define classical architecture in relation to the body, must not modern architecture (as both groups agree) be defined in relation to the *absence* of the body?[271] This relationship to the absence of a body has created, not a new form of architecture, but an "anthropomorphized god-shaped hole around which architectural discourse orbits."[272] Ultimately, this means that modern architecture does not have a constitutive theory of form; phenomenology's attempts to introduce a human body is not a return to humanism, but is instead a reaction to the conditions of modernity.[273] Furthermore, both post-structuralists and phenomenologists must be considered to be conservative, rather than radical, as they both attempt to preserve the relation of the human form to the relation of the body and the continuity of architecture as a field of philosophical and creative endeavor from Vitruvius.[274]

In *En Route*, Hight, Hensel, and Menges seek to expand the notion of heterogeneous space past its position in space-time and social geography where it currently stands. Following a definition of heterogeneous space, the authors touch on a very important point: Space is not only a theoretical construct for architects, but something they must operate within and work with.[275] Thus, it is not enough to accept that heterogeneous space (or any other understanding of space) is simply a theory that does not affect practice—in fact, it has a deep effect on practice. Thus, the role of space

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[271] Ibid., 185.
[272] Ibid.
[273] Ibid., 186.
[274] Ibid., 186–188.
[275] Michael Hensel, Christopher Hight, and Achim Menges, *Space Reader: Heterogeneous Space in Architecture* (Hoboken, NJ: Wiley, 2009), 17.

in architecture needs to be discussed not only for its design implications, but also for its political and social implications.[276]

In *The Heterogeneous Space of Morpho-ecologies,* Hensel and Menges argue that there needs to be a change in existing understandings of space in architecture. In particular, they argue that current conceptualizations of space continue to equate the architectural object with the body in a classical Vitruvian fashion.[277] They do not, however, present any means of actually developing this conceptualization of space, of reaching beyond the human form in architecture, or of implementing this change within the classroom. This is a common failing with many of the discussions of architectural practice, which do not show much inclination to discuss how the changes they suggest should be applied within the classroom or to the activity of architectural students and practitioners.

The problem of how architecture should be taught, including the task of moving beyond the Vitruvian rectification of the human form in the architectural object, is taken up by Erich Jantsch. In *Education for Design*, he presents a comprehensive problem statement about architecture and the desired curriculum, culminating in a presentation of how this problem could actually be solved within the classroom. Jantsch begins by questioning the basis of the university—that the rational and objective transfer of knowledge and information to students is possible and even that design can be taught

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[276] Ibid., 35.
[277] Michael Hensel and Achim Menges, "The Heterogeneous Space of Morpho-ecologies," in *Space Reader: Heterogeneous Space in Architecture*, ed. Michael Hensel, et al. (Hoboken, NJ: Wiley, 2009), 196–208.

(though he does concede that it can perhaps be learned). [278] Instead, Jantsch recommends addressing the *total human experience* within the context of the university, including the nature of man, knowledge and emotion, and capabilities and desires. He also suggests that the current definition of design (especially the focus on planning) is far too narrow and must also take into account the cultural, physical, and other aspects of generating knowledge and designs.[279]

Rather than designing objects, Jantsch describes the goal of design as creating human systems, defined as "the structures and initial states of social systems, their policies . . . and the culture that gives life to them."[280] As such, prioritizing the scientific (technological/rational) over the artistic (pre-technological/irrational) is a mistake; both scientific and artistic understanding are forms of knowledge that are valuable and necessary for creation of designs. Finally, structured rationality alone cannot be relied on to generate knowledge since it is inherent in only the most constrained and restricted forms of design (planning); in fact, creativity must be acknowledged since it is relevant to interexperential organization, the underlying core of design.[281]

Jantsch set out a substantial theory of knowledge and experience based on his domains of rationality. Figure 3 shows a schematic approach to Jantsch's domains of knowledge and inquiry and their relevant positions within the total human experience.

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[278] Erich Jantsch, "Education for Design," in *The Universitas Project: Solutions for a Post-Technological Society*, ed. Emilio Ambasz, et al. (New York: Museum of Modern Art, 2006), 111–112.
[279] Ibid., 114–115.
[280] Ibid., 118.
[281] Ibid., 123.

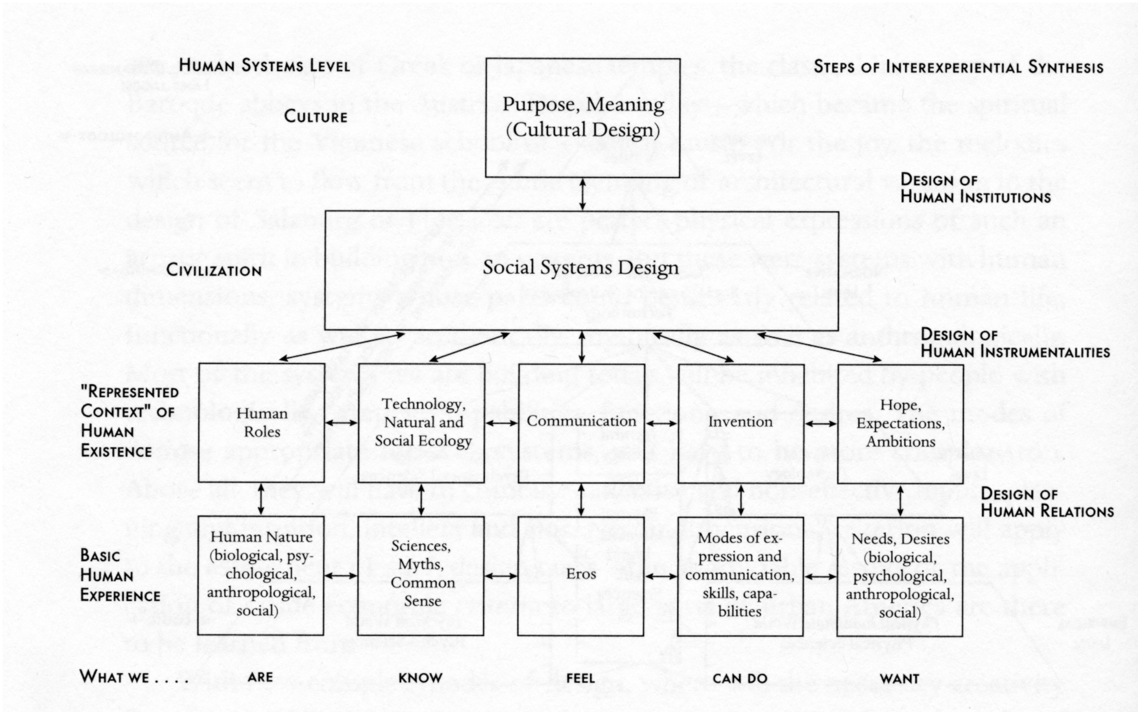

Figure 3. Systems representation of the total human experience and purposeful activity.[282]

The domains of human experience are summarized by Jantsch as "what we are . . . know . . . feel . . . can do . . . [and] want."[283] Of these domains of human experience, only a relatively few can be reduced to the Western understanding of knowledge, but the rest are still important for forming worldviews and systems. Western ways of knowing provide privilege to rational knowledge while de-prioritizing other means of knowing.[284] Jantsch asks the question, "Should we just continue and redouble our efforts to express all our experience in knowledge equivalents, and thereby restrict ourselves to a narrow notion of merely rational inquiry?"[285]

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[282] Ibid., 124.
[283] Ibid., 112.
[284] Ibid., 113.
[285] Ibid., 113.

Jantsch's model of inter- and trans-experiential inquiry is based on observations regarding human systems design and the difference between scientific and artistic modes of inquiry. Human systems planning has a number of weak points, including a reactive rather than anticipatory bias and a preference for scientific inquiry.[286] As Jantsch points out, this demands cultural change; however, this change cannot, paradoxically, be accomplished with existing modes of inquiry, which ignore aspects of culture (what we feel, can do, and want). Furthermore, the Western understanding of development as a linear and evolutionary process is at odds with the need to consider a whole-ecology world system.[287] Thus, designing human systems involves not just designing institutions and organizations, but also the underlying social systems and human instrumentalities.[288] Jantsch also sees a need to eliminate the false dichotomy between arts and sciences.[289] In order to overcome these limitations and dichotomies, Jantsch suggests that it would be effective to undertake an interexperiential framework for knowledge.[290]

Educational Structures

Jantsch derives a series of guidelines for education relative to design.[291] These principles aim to the total human experience within the designer and enhancing the designer's organizational capabilities regarding this experience, including the ability to organize and interact with it through inter- and transexperiential modes of expression and

[286] Ibid., 114.
[287] Ibid., 116–117.
[288] Ibid., 118.
[289] Ibid., 121.
[290] Ibid., 123–124.
[291] Ibid., 128.

inquiry. These goals are seen as a means of balancing a series of dichotomies (e.g., nature/artifice and instinct/culture) as well as increasing the designer's *awareness* of his or her own total experience.[292] In order to enact these aims, he suggests that basic structures of human relations, human instrumentalities, and human institutions would be appropriate for the teaching of design.

The first structure is the design of human relations, by which Jantsch means not just interpersonal relations but also relationships between the human and his or her experience in the world.[293] The key aspect of this stage of learning is the development of measurements of the impact of technology in human terms, rather than measurement of humans in terms of technology. The key curricular aspect of this stage, according to Jantsch, is that creativity and communications skills (two foundational elements of the design process) must be systematically taught.

The second critical structure for learning discussed by Jantsch is the design of human instrumentalities "as a mode of organizing the 'represented context' of human existence into social systems."[294] This phase is perhaps the weakest in terms of its development; as the normative stage, it relies on the further development of the comprehensive normative theory that Jantsch proposes.[295] This stage serves as a bridge between the design of human relations and human institutions (the bottom and top level of analysis respectively) because human instrumentalities or means (especially social systems) serve as the central point of connection between these two areas.

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[292] Ibid.
[293] Ibid., 129–31.
[294] Ibid., 128.
[295] Ibid., 133–34.

The third educational structure proposed by Jantsch is the design of human institutions. This stage is seen as a means of organizing *culture*, or the deep structure underlying human institutions (such as laws and nations).[296] Furthermore, this area of inquiry is targeted to an exploration of the "ethics of whole systems"[297] and the problems that result from attempted changes in this level of design. Given that this is particularly an axiological (value-based) level of inquiry, the focus on politics, ethics, and ecology is particularly relevant as determinants of existing axiological systems. Furthermore, Jantsch suggests that this level of analysis is particularly well-suited to practical design and laboratory systems, as well as studies of dynamic behavior.[298]

A summary of these structures and their basic characteristics is shown in table 1.

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[296] Ibid., 134.
[297] Ibid., 135.
[298] Ibid., 136.

Table 1. Systems representation of the total human experience and purposeful activity[299]

Educational Structure	Nature of Learning	Principle approach to interexperiential synthesis	Formal disciplines and areas of inquiry to be studied at each level
Design of Human Institutions	Evolution of Values	Cultural cybernetics (axiological method)	• Industrial and post-industrial anthropology • Values and value dynamics • Ethics • Concepts of evolution at various levels • Cybernetics • Information theory • Dynamic modeling • Normative planning • Institutions, religions, and ideologies
Design of Human Instrumentalities	Evolution of Norms	Social cybernetics (normative method)	• Rational and creative planning • Innovation • Advocacy • Political science • Systems theory • Organizational theory • Complex dynamic systems • Operations research • Forecasting • Social indicators • Decision theory and decision processes • Resource allocation
Design of Human Relations	Evolution of Measure	Human cybernetics (conceptual method)	• Biology • Psychology • Behavioral science • Anthropology • Art history • Aesthetics • Forecasting • Reflective consciousness • Ecosystems • Myths • Semiotics

[299] Adapted from Ibid., 128–138.

There are a number of general structural points that Jantsch makes about his planned approach to inquiry. First, learning must be a combination of formalized learning (e.g., classroom and laboratory) and nonformalized experience (i.e., life) in order to be successful; the systematic integration of life experience is what makes the learning process effective.[300] The three levels of learning should be integrated in order to take advantage of feedback loops between all levels, which incrementally improve the connections between the learning process and the represented context of the world.[301] The focus in designing human systems should not be on *structures*, but instead on *processes*; that is, a cybernetic or process-based approach to design should be utilized, rather than a heuristic or structure-based approach.

A particular weakness of this model is that it depends on the establishment of an as-yet-undeveloped, but highly comprehensive, normative theory.[302] This normative theory must encompass elements of formal, empirical, pragmatic, aesthetic, ethical, and evolutionary norms, and must be sufficient to allow design and redesign even of deep cultural systems based on this normative theory. This is an exceptionally high barrier, particularly given the multiplicity and ingrained nature of cultural systems in general, and from the researcher's view, it prevents the full implementation of this curriculum because, by necessity, no such fully-formed normative theory is likely to be plausible. A more minor point is that, although Jantsch has made it clear that knowledge (i.e., the fruit of rational inquiry) should be integrated into the curriculum along with non-rationalized experience, the topics he has presented represent—not this non-rationalized experience—

[300] Ibid., 132.
[301] Ibid., 136–139.
[302] Ibid., 138.

but rationalized theoretical models of the non-rationalized experience of others. Jantsch does not offer any specific way to perform this task either. Thus, although this is presented as a means of integrating knowledge and experience, the experiential part of the curriculum is in fact missing. This does not, however, reduce its value in terms of a curriculum designed to promote knowledge, and this value should be recognized.

Summary

The main purpose of this chapter has been to discuss the current state of theoretical discussion surrounding the role of technology in architecture. This is an extensive and nuanced discussion that does not take for granted any particular facet of the problem, from the definition of technology itself to the role of technology. Additional issues in current architectural theory include those of space and time, the self and the body, and the continuity of architectural knowledge and practice over time. Each of these areas of concern has been explored in detail through the use of critical summaries of key texts within these fields.

The chapter began with an overview of modernism in architecture, particularly within the first half of the 20th century. After a review of the Bauhaus and Vkhutemas schools, including their structures, curricula, and pedagogies, the history of architectural education in the U.S. was given. After the historical discussions, the chapter switched focus to discuss the role and practice of using technology in architecture.

The first topic for discussion was information technology. Information technology, or technologies focused on manipulation or distribution of information (e.g., text, knowledge, music), are the most common technologies used in the architectural field, although there are others, such as fabrication technologies. The first section of the chapter traced various facets of information technology as used within architecture, identifying key aspects of this technology.

While the first section of the chapter described the uses of technology, the second section of the chapter critiqued these uses. The most fundamental theme in this section was that a position of crude technological determinism was wholly inappropriate for considering this role. Instead, it was important to think about what technology is, how it has been implemented, what role it plays, how this role had emerged over time, and what it has meant in modernity and postmodernity. Other important concerns were how technology could be used to enhance learning and what the role of multidisciplinary learning is. These debates are particularly important because a critical view toward the use and role of technology is needed to make sure that it is not taken for granted.

The chapter concluded with a discussion of the current debates within the field of architecture. These debates included questions about the nature of space and time, the architectural object and its relation to the self and the body, and the need to consider the historical nature of architectural knowledge and its continuity over time. These debates show that the nature of architecture is continuous and has not undergone a radical change over time despite the increasingly rapid introduction of CAD and other technologies. Thus, the current debate can be understood as a gradual continuation of previous concerns, rather than a significant break.

This information particularly reflects on issues that emerged during the research process, including issues of embodiment, techné and skill, space and form, as well as political, social, and pedagogical concerns that tie historical and future uses and views of technology and the body together. The information within this chapter shows parallel development of European and American schools of architecture, which merged during the modern period to generate a new form of philosophical and pragmatic approach. There are still some significant issues that remain to be explored, especially given the unremarked (and barely studied) presence of technology in the architecture classroom; this is the task of the current research.

CHAPTER 3: RESEARCH METHODOLOGY AND METHODS

Phenomenological methods and philosophy guide this research. The phenomenological approach evolved from a grounded theory framework, which directed the outcomes of the phenomenological analysis in order to suggest theories regarding the emergence of advanced technology in contemporary architectural pedagogy. Grounded theory methods "consist of systematic, yet flexible guidelines for collecting and analyzing qualitative data to construct theories grounded in the data themselves."[1] It is an inductive research approach that begins from an observation, as opposed to a hypothesis, working backward in order to identify a potential explanation for that observation.[2] The observations have been derived from the phenomenological interviews and other information collected.

Phenomenology is a complex method of inquiry, as well as a research philosophy, that does not seek to explain cause and effect, but rather to identify the essence of a given phenomenon (or occurrence, happening, internal state, or other combination of sensing, perception, thought, memory, and experience). There are numerous variations of phenomenological research, but the approach used in this research follows that of Amadei Giorgi, who built on the constructive phenomenological approach spelled out by Edward Husserl.[3] This particular phenomenological process involves three steps: 1) data collection (i.e., interviews in which descriptions of the experience and context are co-

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[1] Kathy Charmaz, *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis* (London: SAGE, 2006), 2.
[2] Antony Bryant and Kathy Charmaz, eds., *The SAGE Handbook of Grounded Theory* (Thousand Oaks, CA: SAGE, 2010), 1–2.
[3] Amedeo Giorgi, *Phenomenology and Psychology Research* (Pittsburgh: Duquesne University Press, 1985), General discussion throughout the book details this method.

created), 2) data sorting or phenomenological reduction, and 3) essence identification. Phenomenology is both a philosophical and a methodological approach to research.

The combination of phenomenology and grounded theory serves two purposes. First, the phenomenological study provides a philosophical and descriptive framework for the phenomena that were encountered within the area of inquiry. Second, the grounded theory study creates a generalizable theory using this framework. The resulting theory could then be tested in further research. Figure 4 shows the overall plan of the research, based on phenomenology-led integration of these two methods. In keeping with the fundamental separation of the two approaches (the only direct connection between them being the use of the same interview data), the two approaches are discussed separately.

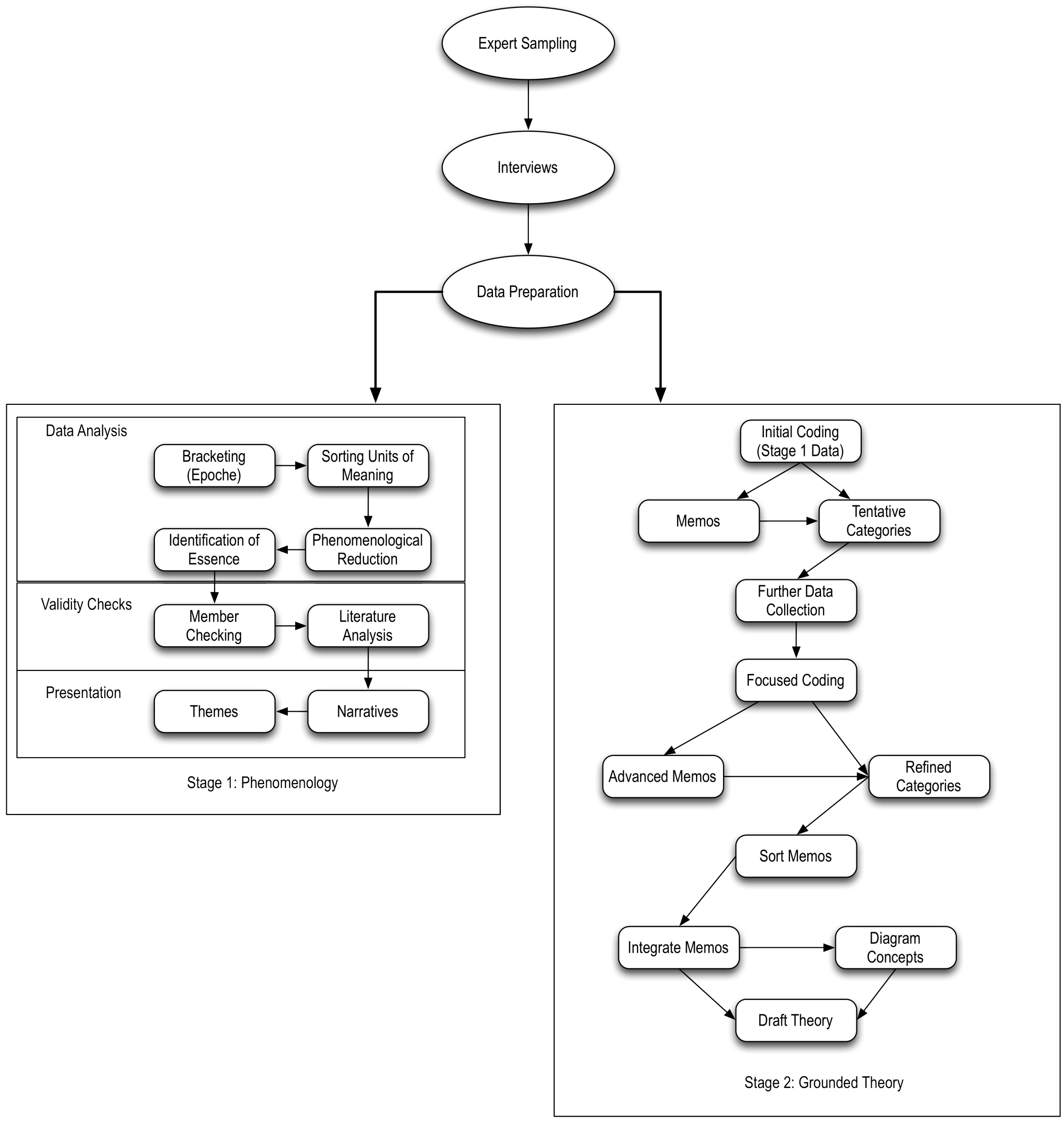

Figure 4. Integration of Phenomenology and Grounded Theory Stages of Inquiry.

Initial Research Stages

The sampling protocol and selection of participants, conducting of interviews, and preparation of data was the same for both phenomenological and grounded theory analysis stages. This is justified because the approach to data collection for both phenomenology and grounded theory is very similar, and it is only in the analysis stages that the two methods begin to diverge.

Sampling Procedure and Sample

The use of a common approach for phenomenology, that is, conducting qualitative interviews among a selected group of participants, also characteristic of grounded theory and did not reduce its usefulness. The purposeful sampling method, known as expert selection, is appropriate for qualitative research as it ensures that the sample includes individuals that have experienced the desired phenomenon or have the required knowledge to provide insight into the research.[4] This method of selection must be used in phenomenological research to ensure that the phenomenon can be identified in the sample.

Data collected and analyzed in this study are in the form of interviews conducted with a sample of experts. The specific criteria by which participants were selected included knowledge of and experience in architectural pedagogy and technology.

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[4] John W. Creswell, *Research design: Qualitative, Quantitative, and Mixed Methods Approaches* (Thousand Oaks, CA: SAGE, 2009), 252.

Although experts were sought out, they were not the only participants in the research. The participants come from a wide range of backgrounds and are currently involved in a variety of positions that are relevant to the topic of the research. Table 2 (see Appendix A) provides a brief description of the participants in this research.

When selecting the participant, the researcher was mindful of gathering diverse individuals who hold varying views regarding the role of advanced technology in architectural pedagogy. The participants represent different backgrounds, generations, and levels of involvement with advanced technologies. Some of the participants are skeptical of the role of technology; others are not only involved in academia but also in creating and developing programming languages such as Firefly and Python, which both run within Rhinoceros 3D. The researcher initiated contact by sending e-mails to instructors from well-known schools that are involved with the integration of advanced technologies in their pedagogies. Several names of schools were recommended by Dr. Renata Hejduk and Assistant Professor Jason Griffiths; with their help, the researcher was able to communicate and meet with some of the participants. Throughout the selection process, the researcher took into consideration their knowledge, experience, and involvement in use of advanced technologies in architecture and design education.

Interviews

In preparation for the interviews, the researcher read a number of books/articles that detail the interviewing process and issues that can emerge during interviewing. This included reading about both creating interview questions and performing the interview, especially focusing on verbal and non-verbal communication. The most effective of these materials included Seidman,[5] who discussed interview techniques and a structured interview approach, and Judee Burgoon, Laura Guerrero, and Kory Floyd, who provided detailed and comprehensive information on detecting, analyzing, and interpreting nonverbal communication.[6]

The researcher also used a pilot process to practice the interviews and refine the interview questions. A pilot interview is used for a number of purposes, including improving the researcher's interview skills and ease in asking questions, working out technical issues, and identifying potential problems with the wording of questions.[7] This pilot process involved conducting interviews with three volunteer interviewees familiar with architectural pedagogy and the field of inquiry (though some were not experts). The pilot interviews were conducted using the original interview guide and were followed by critical discussions about the interview questions and approach. Multiple interviews allowed for refinement of the interview guide and approach.

Interview Procedures

Seidman's approach to phenomenological interviewing was used in this research.[8] Phenomenological interview questions, according to Seidman, focus on the experience under examination, including what participants experience and how they experience it.

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[5] Irving Seidman, *Interviewing As Qualitative Research: A Guide for Researchers in Education And the Social Sciences* (New York: Teachers College Press, 2006), 47.
[6] Burgoon, Judee, Guerrero, Laura, and Kory Floyd. *Nonverbal Communication*. Boston: Allyn & Bacon, 2009.
[7] Seidman, *Interviewing As Qualitative Research, 47*.
[8] Ibid., 16–18.

This should not include questions about *why* something occurs, only about *how* it occurs. Seidman recommends a series of three interviews separated by some period of time to give the researcher and participant a chance to reflect on the previous interviews. The participants approached for the study could not commit to this multipart process; it was therefore collapsed into a singular interview of longer duration. The interviews, up to two hours long, addressed past and present experience as well as the essence of shared experience.

With the exception of two, the interviews were conducted in person, following the advice of Seidman, who notes that it is difficult to make a personal connection and form a trust relationship—as is needed in such personal interviews—via telephone or e-mail.[9] Initially, participants were contacted in person, by telephone, or by e-mail to determine whether they would be willing and available to participate. The research was explained and, upon agreement, a time for the interview was arranged. Interviews were held in surroundings that were comfortable for participants (in most cases their offices). Audio recordings were taken of each interview, and the researcher also recorded field notes (e.g., information and thoughts) on a notepad. The interview began with a technical check to ensure that recording equipment was functional. It then proceeded conversationally, gradually deepening into the interview questions. Participants were repeatedly encouraged to expand on their experiences and discuss them in detail. Following each interview, the researcher maintained contact with the participants and continued to discuss interpretations of experience, ensuring that the findings were consistent with the experience and essence of the interviewees themselves.

[9] Ibid., 45–48.

Interview Guide

The interview guide below contains a representative sample of the questions that were asked of participants. These questions were created in line with the guidelines set out by Seidman. The nature of the phenomenological interview (as will be discussed in further detail below) is that it is oriented more toward the individual and uses a conversational approach; it is not a strictly guided interview. Thus, these interviews are representative but not inclusive of all questions that were asked in the interviews. Individual interview transcripts that detail the specific questions asked of each participant are included in the Appendix.

Pedagogy/curriculum

1. Regarding the influence of technology in contemporary architectural education:

    - Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school?
    - Which models/paradigms of digital technology are informing design pedagogy at your school?
    - How are they integrated into the curriculum?
    - How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (e.g., professor, administrator, student)?
    - What do you think are the positive and negative implications of this?
    - How do you believe technological models have shaped architectural pedagogy historically?
    - Do you believe this relationship will evolve over the next 10–15 years? How?

- Which technologies or technological paradigms do you think will be most influential in the coming years? What are the keys issues that you see arising?

2. On the influence of technology/technological paradigms on the *social formations* and culture of architecture schools:

    - How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

    - What social modes/organizations (e.g., team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

    - Do these technologies positively or negatively affect peer interaction/learning within the design studio?

    - Is there a trend here? Where do you see this leading in the next 10–15 years?

Students

3. On teaching students to critically engage the use of technology in the design studio:

    - Do you teach students to critically engage/question technology and/or technological paradigms within the design studio? How so?

    - Do you teach students to push back on and innovate beyond these paradigms? How so?

    - Do students think critically about how these technologies affect architectural representation?

4. On social responsibility:

    - Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

    - How might this definition of social responsibility evolve in the future in relation to technological advancements?

Faculty

5. What percentage of your design faculty uses and/or requires the use of advanced digital technologies (e.g., parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

6. What are the primary factors that you believe may hold back those faculty members who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

7. Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation?
    a. If yes, is this critical assessment something that happens more individually, or something that has been formally addressed by the faculty as a whole leading to formal or informal school policies on these issues?

8. What are the opportunities that these technologies offer? What is lost by their use?

Economic

9. Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

10. Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Ethical

11. Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Future

12. What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

<u>Data Preparation</u>

Data preparation involved transcription of the raw interview audio files and the integration of annotations from the researcher's interview notes at appropriate points within the transcript. Transcription is the obvious first step in analysis since this provides a basis for semantic analysis and reduces the difficulty in information access.[10] Transcription was performed by an external service in order to prevent errors, such as unconscious insertion based on the researcher's recollections, from occurring during the transcription process. This also allowed for better quality control of the transcriptions as professional transcription was likely to be of a higher quality. Several paper copies of the transcribed interviews were prepared as working copies. To prevent data loss and allow for reprinting of new copies if necessary, the transcriptions were also stored as electronic files (in Microsoft Word and PDF format) on an encrypted USB stick.

Phenomenological Stage of the Research

Stage 1 of the analysis was phenomenological. The overall process of analysis is shown in Figure 5 (although the sampling and data collection phases took part as above). In this section, the philosophy and process of phenomenological analysis is discussed in detail to demonstrate the analytical stages of this stage of the research. Figure 6 shows an example of one of the questions along with the process of phenomenological reduction with one response that was undertaken. The questions and responses varied between different respondents, and as such, this is only a representation of a possible approach to one of the questions.

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[10] Richard H. Hycner, "Some Guidelines for the Phenomenological Analysis of Interview Data," *Human Studies* 8 (1985): 280.

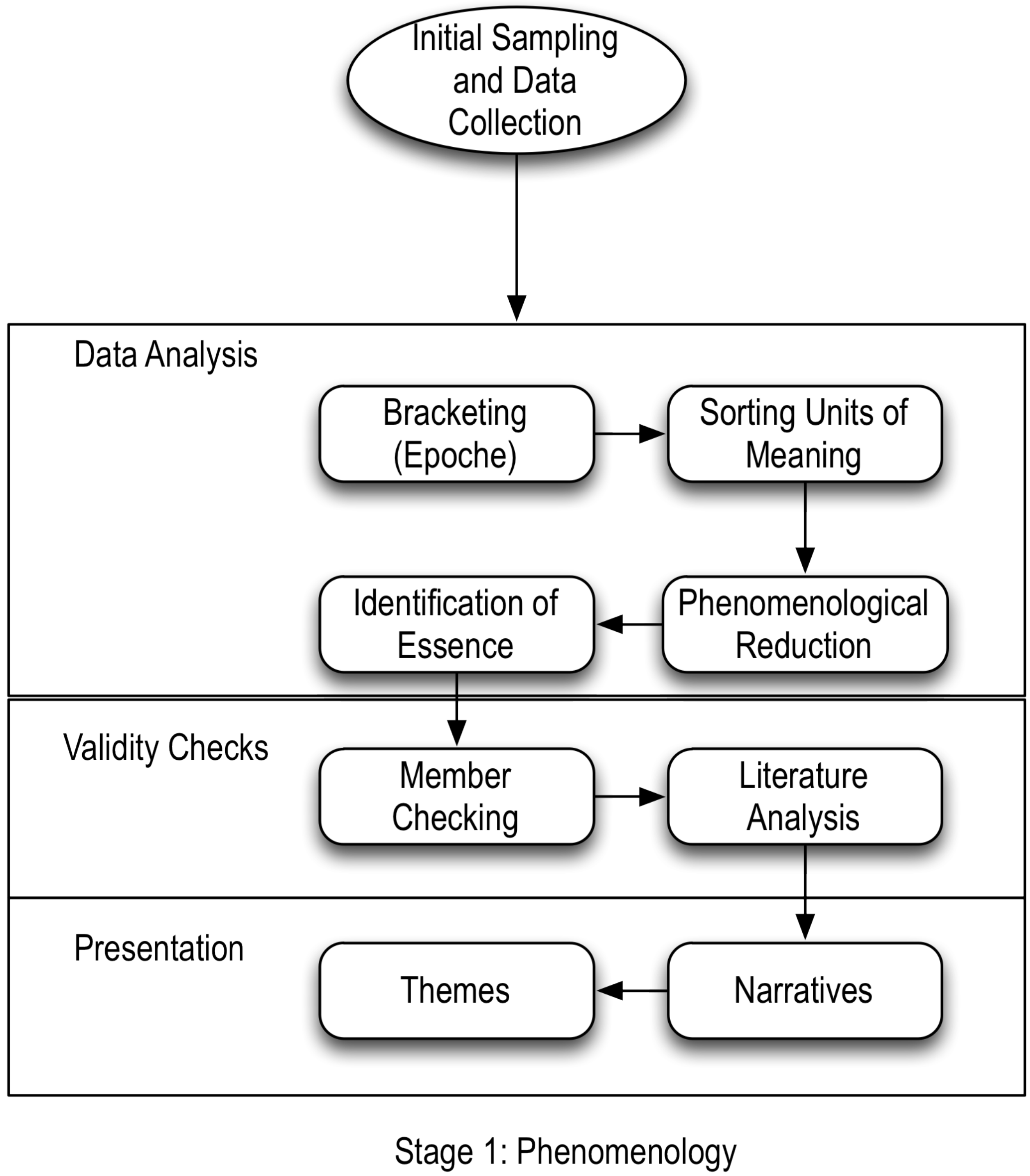

Figure 5. Overview of Stage 1 of the research method (Phenomenology).

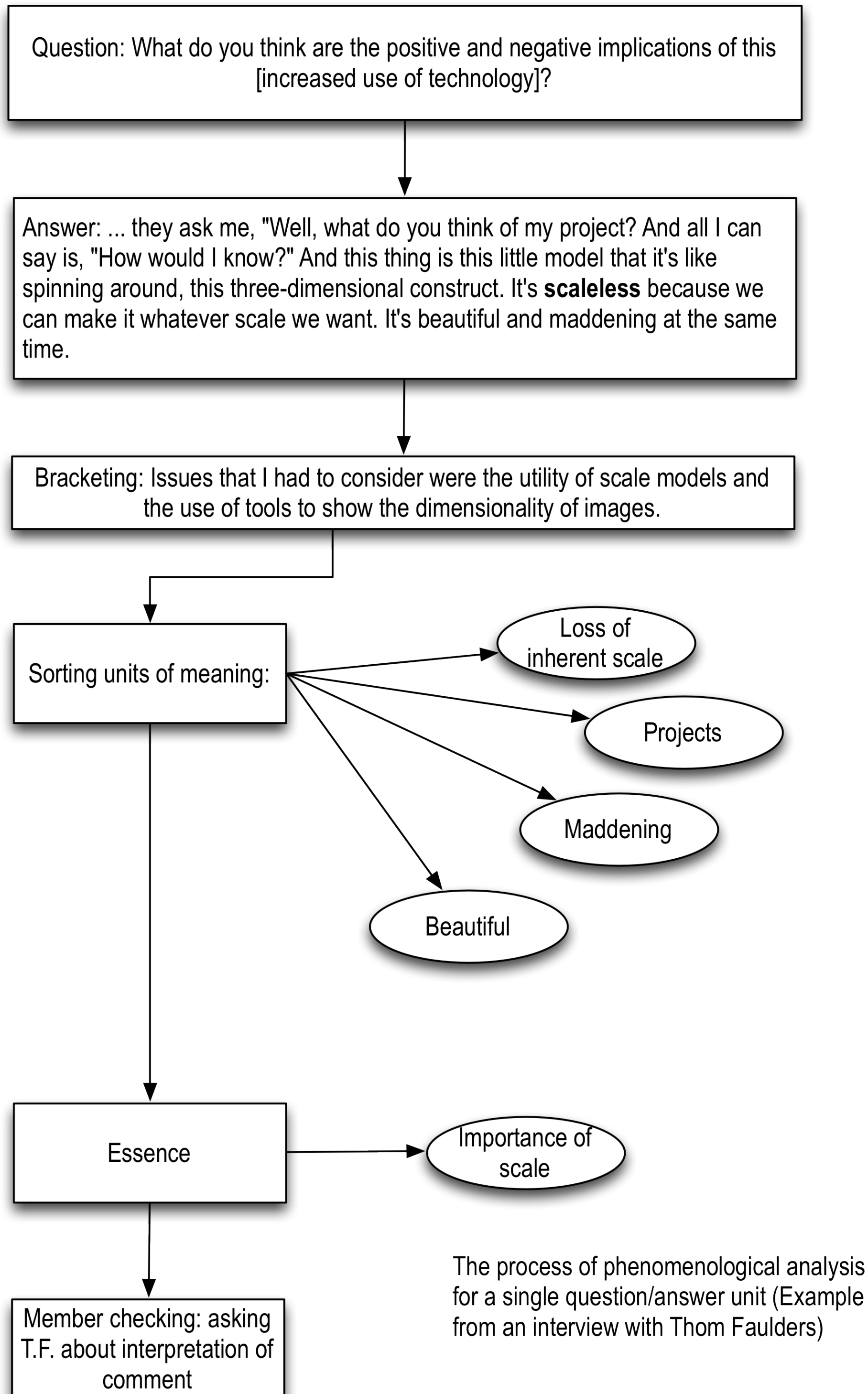

Figure 6. The process of phenomenological analysis.

Phenomenology as a Philosophy

The beginnings of phenomenology as a philosophy can be seen in Hegel's *Phenomenology of Spirit*, which connects the empirical experience and interior emotional state to an objective underlying reality. This philosophy begins from a simple assumption that "man is a rational animal"[11] and therefore understands his experience from the viewpoint of rationality. This reasoning is an expression of consciousness that seeks to understand both the internal and the external variations in meaning created by experience. This results in self-consciousness, or an attempt to produce an understanding of the individual's experience of the world.[12] Yet, rationality and self-consciousness alone are inadequate to understand the human experience; instead, *Geist* (or spirit) must also be taken into account.[13] Verene states, "Geist or spirit as the subject matter of phenomenology is the human self in all of its actual guises, including its proto-social, religious, and philosophical forms."[14] Spirit is the manifestation of the fact that, in addition to being a rational animal, "man is a social animal."[15] Thus, the dual state of rationality and sociality results in a condition where phenomenology, or understanding of the experience itself, is a key element in the human cognitive process.

The modern research practice of phenomenology is largely based on the philosophy of Edmund Husserl, who pioneered the development of phenomenological

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[11] Donald Phillip Verene, *Hegel's Absolute: An Introduction to Reading the Phenomenology of Spirit* (Albany: State University of New York Press, 2007), 76.
[12] Ibid., 79.
[13] Ibid., 82.
[14] Ibid., 83.
[15] ibid.

reduction and the movement from descriptive to transcendental phenomenology.[16] According to Ricoeur's discussion of Husserl's movement toward the transcendental approach, it resulted from an acknowledgement that the phenomenological reduction was not just a description of reality, but was in fact an ontological statement about the nature and meaning of reality. In Husserl's view of phenomenology, there are two key points that lead to the transcendence of reality (or understanding of reality from the individual view).

First, phenomenology is an expression of the ego: "A non-positional transversal intentionality inherent in the success which consciousness makes with itself is thus placed at the origin of the 'thetic' consciousness which posits things or significations as in-themselves."[17] That is, the phenomenon does not have significance outside of the ego. Second, in addition to the ego, the "other" must be taken into account within phenomenology. Intersubjectivity (connections and overlapping between egos) leads to partial incorporation of the other into ego.[18]

As Ricoeur points out, this is one of the fundamental problems of Husserl's phenomenology. It is also the area where there is room for the understanding of shared reality, incorporation of the experiences of others, and the development of intersubjectivity. In particular, the creation of "a world held in common within the intersubjective network of experience"[19] is the fundamental focus of phenomenology as a philosophy and is its foundation as a research method.

[16] Paul Ricoeur, *Husserl: An Analysis of His Phenomenology* (Chicago: Northwestern University Press, 1967), 9.
[17] Ibid., 11.
[18] Ibid.
[19] Ibid., 131.

Phenomenology as a Research Method

The phenomenological approach to research has been explored by Georgi (1985), Seidman (2006), Sokolowski (2000), and others as a means of understanding the direct experience and contexts of experience, as well as deriving an intersubjective interlapping of ego (that is, creating a shared understanding between self and other). This first section describes the definitions that are used in phenomenological research, while the following sections describe the specifics of sampling, data collection, and data analysis.

Definitions

Although phenomenology is distinct as a research method, it shares several concepts with other approaches. This section provides a definition of the unique elements of phenomenology that were used in this research.

Phenomenon

A phenomenon can be understood as an experience, concept, or paradigm that helps to explain a combination of empirical and rational inputs, along with emotions and other information (such as thought and memory).[20] One of the simplest examples of a phenomenon is love, which everyone understands even if they do not experience it in exactly the same way. Most importantly, it represents an authentic description of being in

[20] Sherill A. Conroy, "A Pathway for Interpretive Phenomenology." *International Journal of Qualitative Methods* 2, no. 3 (2003): 38.

the world, involving interpretation and co-constitution of meaning from time and experience.[21] Using a hermeneutic circle approach, a phenomenon is defined in layers of meaning and in different contexts to integrate different views of different egos.[22]

Although the definition of a phenomenon is in some senses easy to understand, since it represents our shared view of experiences and feelings, it is also paradoxical in nature. The phenomenon is presumed to derive from an internal wellspring of sense and experience of the individual; yet at the same time, the "world-phenomenon"[23] is shared between individuals—it is intersubjective and presumed to be universal. For example, each individual experiences pain as unique, but it can also be described scientifically using common physical experiences that are not unique to the individual (such as neuron response and autonomic nervous system responses like increased heart rate). Thus, understanding the phenomenon as a simple individual experiential description is inadequate.

Phenomenology results from consideration of the phenomenon, not just from a propositional attitude (rationally) but also from a philosophical attitude (spiritually).[24] In other words, it considers not just how love or pain occurs, but what it means from a spiritual or philosophical viewpoint.

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[21] Ibid., 39.
[22] Ibid.
[23] Robert Sokolowski, *Introduction to Phenomenology* (Cambridge, UK: Cambridge University Press, 2000), 189.
[24] Ibid.

Essence

The essence of the phenomenon can be understood as the product of eidetic reduction, in which the individual experience is reduced to its fundamental elements.[25] An object or identity's essence may also be a morphological thing; it is an ambiguous and variable construct that can vary or even evolve depending on the experience and the ego.[26] Essences may be deduced through the use of *eidetic intuition*, or intuition into *eidos* (the identity of things).[27] The process of eidetic intuition exists in three stages.[28] The first stage is determination of typicality, a weak identity that describes certain shared characteristics of a class of phenomena. In the second stage, determination of an empirical universal, it is recognized that all phenomena of that class share the characteristic. In the third stage, imaginative variation is used to consider what changes could be made within the phenomenon. Elements that cannot be altered without changing the nature of the phenomenon are considered to be fundamental to the phenomenon; it is these elements that are considered to be the essence of the phenomenon, rather than those derived at the previous two stages of analysis. For example, the phenomenon of pain is essentially a phenomenon of unpleasant nerve stimulus; other determinants may not be included in this essence (like fear, which is not always present).

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[25] Ricoeur, *Husserl*, 146.
[26] Sokolowski, *Phenomenology*, 160–161.
[27] Ibid.,187.
[28] Ibid., 187–189.

Phenomenological Statement

The basic research product of the phenomenological research process is the phenomenological statement. Phenomenological statements "tell us what we already know… . Even if they do not tell us anything new, they can still be important and illuminating because we are often confused about just such trivialities and necessities."[29] They are, according to Sokolowski, a basic statement about the experience under consideration, its context, or other aspects, such as between whom it is shared. The phenomenological statement does not serve to demonstrate the causes and effects of the phenomenon, but instead defines it so that it can be understood by everyone. That is, they are *apodictic* statements that "express things that could not be otherwise; they express necessary truths."[30] Such statements are precise and accurate, adequate to convey a precise truth without vagueness or ambiguity, and have considered all the implications of the context and the phenomenon as expressed.[31]

One example of a phenomenological statement (compared to a non-phenomenological statement) can be found in a discussion of Goethe's scientific work in prisms.[32] A phenomenological statement regarding this occurrence is "colors appear at edges of dark-light contrast," which is a statement that can be verified using human observational capacity. In contrast, "the prism refracts the light into colors" is not a phenomenological statement; although this describes what is occurring in a physical

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[29] Ibid., 57.
[30] Ibid.
[31] Ibid.
[32] David Seamon, "Goethe's Way of Science as Phenomenology of Nature," *Janus Head* 8, no. 1 (2005): 89.

sense, humans cannot sense refraction. In essence, the phenomenological statement serves to describe non-judgmentally, clearly, and accurately the experience and context of the phenomenon under examination as experienced by the participants without imposing the judgment of the researcher.

Noema and Noesis

Noema and noesis are fundamental elements of transcendental phenomenology (or phenomenology that attempts to explain the nature of reality).[33] These two terms are correlates of each other, with noema signifying the "object-side of consciousness" and noesis signifying the "subject-side of consciousness."[34] These terms are unique to transcendental phenomenology, and they do not have a precise synonym within other research approaches.[35] Although these terms are frequently misunderstood, there are relatively simple definitions offered by Sokolowski. He describes noema as follows:

> Any object of intentionality, any objective correlate, but considered from the phenomenological attitude, considered just as experienced. It is not a copy of any object, not a substitute for any object, not a sense that refers us to the object; it is the object itself, but considered from the philosophical standpoint.[36]

A simplified definition is that the noema is the object or content of a thought, judgment, or perception. Sokolowski states that noesis is more readily understood as it signifies "the intentional acts by which we intend things: perceptions, signifying acts, empty intentions,

[33] Ricoeur, *Husserl*, 21.
[34] Ibid
[35] Sokolowski, *Phenomenology*, 69.
[36] Ibid., 70.

filled intentions, judgings, rememberings,"[37] once again as understood from the phenomenological, philosophical viewpoint. Due to their description of the content of thoughts, these two terms can be used to understand how a phenomenon is constructed.

Data Analysis

Data analysis was conducted in four stages: 1) bracketing (or epoche), 2) identifying and sorting units of meaning and summarizing individual responses, 3) imaginative variation and data sorting (phenomenological reduction), and 4) analysis (identification of essence). The following step-by-step discussion describes the process that was used for each stage of analysis as well as the intended outcomes.

Bracketing (Epoche)

Bracketing, or epoche, can be defined operationally as "suspending . . . as much as possible the researcher's meanings and interpretations and entering into the world of the unique individual who was interviewed."[38] Fundamentally, it is a process of critical reflection and deliberate setting-aside of views regarding the object of consideration. In terms of philosophical meaning, bracketing or epoche means suspending the researcher's own worldview (*Weltanschauung*), which is the only way to enter the transcendental experience space.[39]

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[37] Ibid.
[38] Hycner, "Phenomenological Analysis," 281.
[39] Ricoeur, *Husserl*, 95.

By removing the barriers to understanding the essence of the phenomenon and allowing for it to emerge through the experience of the participant, this technique is intended to eliminate the prejudices and preconceptions of the researcher regarding the phenomenon.[40] The bracketing process, however, does not involve ignorance or rejection of existing meaning. Sokolowski writes:

> When we so bracket the world or some particular object, we do not turn it into a mere appearance, an illusion, a mere idea, or any other sort of merely subjective impression. Rather, we now consider it precisely as it is intended by intentionality in the natural attitude. We consider it as correlated with whatever intentionality targets it. If it is a perceived object, we examine it as perceived; if it is a remembered object, we now examine it as remembered. [41]

The process of bracketing is the first stage in the actual analysis process; the transcription stage is preparation. As bracketing is an internal process of reflection and preparation, no specific output can be attributed. A reflective statement describing the bracketing process is included in the *Results*.

Units of Meaning

For each interview, unique units of meaning have been identified. A unit of meaning can be a word, phrase, sentence, or larger piece of the interview that illustrates the essential meaning of the entire discussion.[42] For example, "tools" and "creative elements" are two units of meaning that could be derived related to computers, and each one would indicate a different connotation. This approach, described by Hycner, involves

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[40] Ibid., xiv.
[41] Sokolowski, *Phenomenology*, 69.
[42] Hycner, "Phenomenological Analysis," 282–290.

listening to and reading each interview; identifying a sense of the whole interview; identifying individual units of meaning; isolating units of meaning related to the research question; grouping units of meaning and creating clusters, and then themes, of those meanings; and summarizing the themes and meanings found in each interview. This process helps to generally determine the content of each interview and determine how it applies to the overall themes. This is a fundamental part of the research process as it prepares the individual inputs of the interviews for comparison and identification of phenomenological essences.[43]

Eidetic Intuition (Imaginative Variations)

Eidetic intuition, in which essences are identified from facts, is one of the key elements of the Husserlian transcendental phenomenology approach.[44] The process of eidetic intuition is that of identifying essences (as described above) through imaginative variation during the third stage of analysis. Imaginative variations are a familiar element of human rationality and inquiry, occurring in the sciences, in fiction, and in other settings where there is the application of imagination to existing and known information to determine what variations are possible.[45]

Imaginative variation does not involve wholesale invention of phenomena, but instead involves considering a known phenomenon and its potential characteristics. According to Sokolowski, imaginative variation, while it allows for the development of a

[43] Ibid., 293.
[44] Ricoeur, *Husserl*, 42.
[45] Sokolowski, *Phenomenology*, 200.

wide understanding of the phenomenon, must still comply with the known rational and spiritual requirements of the actors and the context; that is, posing something that does not meet these requirements is fundamentally outside the bounds of phenomenological research. The goal of imaginative variation is to identify eidetic necessities, or truths that are so deeply ingrained in our consciousness and cognitive processing that they are rarely expressed explicitly—instead, they are generally understood.[46]

The eidetic intuition is intended to identify the Platonic ideal form of the phenomenon, which describes only its fundamental elements, those elements that, if eliminated, mean that the phenomenon is no longer itself. As Sokolowski points out, eidetic intuition and identification of imaginative variations is not always successful; however, the process of eidetic intuition is necessary to prepare the researcher for examining the phenomena based on the interview outcomes.

Data Sorting (Phenomenological Reduction)

Phenomenological reduction was conducted using the five-stage approach described by Denzin, which includes:

1) identification of key statements,

2) contextualization and identification of potential meanings,

3) confirmation of these interpretations with the participants,

4) analysis for essence or recurrence of meaning, and

[46] Ibid., 201.

5) preliminary formulation of the essential meaning of the statement.[47]

Denzin's five-stage process serves to identify specific phenomena from the prepared units of meaning revealed through Hycner's approach. The goal of the initial reduction is the determination of the natural essence (as compared to the transcendental essence) of the phenomena described.[48]

The goal of phenomenological reduction is not only the identification of experiences or objects, but also reduction of these objects and experiences to their fundamental elements—that is, the elements that are eidetically necessary for the phenomenon to *be* the phenomenon and not something else.[49] The transcendental reduction incorporates the eidetic reduction, which integrates the features of objects, their correlates (noema and noesis), and the subjectivity and intersubjectivity of the phenomenon.[50] The process of phenomenological reduction is fundamentally one of philosophical reflection, in which all possible interpretations and iterations of the phenomenon are considered. Sokolowski discusses this reflective process:

> This is reflection with a vengeance; it is wholesale reflection. Nothing is left out. We take a distance toward everything, even to the world as such and ourselves as having a world. We do not hold on to several beliefs as a base to give us leverage; we do not retain a floor to stand on. We do not leave any convictions untouched. All of them, even the most basic, are suspended and reflected upon.[51]

The output of this process is a basic understanding of each of the phenomena that will be described, including which can be used to identify the essence of the research.

[47] Norman K. Denzin, *Interpretive Interactionism (Aplied Social Research Methods)* (Thousand Oaks, CA: SAGE, 2002), 55–56.
[48] Sokolowski, *Phenomenology*, 204.
[49] Ibid.
[50] Ibid., 206.
[51] Ibid., 209.

Analysis (Identifying Essence)

The final stage of the analysis process is identifying the essence of the phenomenon from the possibilities presented during phenomenological reduction. (This process is, somewhat confusingly, referred to as analysis by phenomenological theorists.) The essence of the phenomenon can be briefly understood as the characteristics without which it would cease to be the phenomenon (for a detailed definition of this concept see Phenomenology as a Research Method section above).

During the final analysis, all elements of the phenomenon were considered to determine which were truly essential. A single phenomenological description for each of the research questions was revealed through the integration of: 1) the results of the eidetic intuition of imaginative variations, 2) the outcomes of phenomenological reduction, and 3) the inputs of respondents (who were asked to confirm the analysis at every stage). The essences identified for each of the phenomena are intended not only to describe the fundamental characteristics, but also to provide insight into the limitations of the natural attitude (that is, the common-sense first and second order analysis of the phenomenon and determination of its characteristics).[52] In other words, they are intended to be transcendental as well as naturalistic. The essences are considered to be the final output of the research as they are the essential goal for phenomenological research. These essences are described in ideal terms and are supported by the findings as well as specific descriptions of the phenomena from the point of view of the participants.

[52] Ibid., 83.

Research Rigor

A significant concern for this research is the rigor of the research design—that is the validity and reliability of the methods and associated results. Research rigor is a critical issue in all research, particularly qualitative studies, which are open to charges of bias and misinterpretation (even if they are not actually more prone to this than quantitative studies). Regardless, there is no singular approach to evaluation. In fact, one group of researchers identified no less than 24 different approaches for testing the validity and reliability of qualitative research, each with its own set of threats, challenges, and solutions.[53] Clearly, it is not possible to address all of these concerns, and as such, there is a need to identify the most fundamental threats to research rigor within this particular project and to discuss how these threats were mitigated.

One component of research rigor is the trustworthiness of the researcher, both to readers of the research and to participants.[54] According to Harrison, McGibbon, and Morton, trustworthiness is needed to create connections between the researcher and participants on one side and, additionally, to create connections between researcher and reader. The formation of trustworthiness is dependent on reciprocity between researcher and participants as well as researcher and reader. This means that the research must offer something to the participant and reader as well as taking something. In order to generate trust between researcher and participants, the researcher chose to approach participants as equal components in the research and to use an aggressive process of member checking

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[53] Anthony J. Onwuegbuzie and Nancy L. Leech, "Validity and Qualitative Research: An Oxymoron?" *Quality and Quantity* 41 (2007): 233–249.
[54] Jane Harrison, Lesley McGibbon, and Missy Morton. "Regimes of Trustworthiness in Qualitative Research: The Rigors of Reciprocity." *Qualitative Inquiry* 7, no. 3 (2001): 325.

to ensure that participants are represented as they would wish to be. In addition, a comprehensive description of the research process is offered to explain why the research is trustworthy for readers and to give readers the chance to critique the research process and researcher.

A second threat to the rigor of the research is the problem of reflexivity, or the position of the researcher within the research itself.[55] Reflexivity is important for educational and pedagogical research because the position of the researcher is a fundamental determinant of how the researcher will examine the situation. Reflexivity is intended to reduce the power of objectivist research, which presents the researcher as an objective data collection and recording device and does not admit any viewpoint of the researcher other than that which emerges from the data.[56] This approach is clearly inappropriate for such a historically situated and contextualized research project as this. Additionally, the researcher acknowledges that he *does* have a strong view on the research questions and an interest in the outcomes of the study. This is only natural since it would neither enjoyable nor profitable for the researcher to conduct research in which he was not interested in the outcome. However, this viewpoint must be limited in some fashion.

As discussed at length above, one of the techniques of the phenomenological research process is that of bracketing; therefore, the researcher's own preconceptions and ideas regarding the phenomenon are set aside to allow the researcher to understand the context of the research from the participants' points of view. This bracketing is a

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[55] Douglas Macbeth, "Qualitative Research Designs : Selection and Implementation." *Qualitative Inquiry* 7, no. 1 (2001): 35.
[56] Ibid., 36–37.

deliberate reflective process in which the researcher identifies and critiques his own assumptions and makes note of any that cannot be discarded (as well as *why* these assumptions cannot be discarded, in his view). This approach helped the researcher explicitly consider his own biases, background, and worldview and reflect on how this may have influenced the findings. There is an explicit statement of potential researcher and participant biases in the findings, which describes the outcome of this bracketing process.

Ethics

Ethical consideration is important for any form of research. The ethical issues of this research include concern for participants and for the appropriate interpretation and presentation of results and other information.

All participants are experts in the field of architectural pedagogy and architectural technology. As such, there could be significant impact on their careers if their views are presented inaccurately or in a way that allows for misunderstanding. This is a significant concern for the researcher as damaging participants' public reputations or otherwise harming them would be a negative outcome for the research. Additionally, this form of misrepresentation would alter the outcomes of the study and reduce its accuracy. To avoid this, the researcher has used a process of member checking. The participants were frequently asked about interpretations of the research and to confirm the findings and determinations. Participants were also asked at the end of the research whether they wanted to continue to participate and were offered the chance to withdraw their inputs.

Participants were also asked if they want to remain anonymous or be identified in their responses.

A second concern for ethics is the accuracy of the research findings. Of course, as described above, qualitative research (particularly phenomenological research) cannot reasonably be designed for reproduction, and the truth of the phenomena revealed through the process may not be universal. As such, a substitution for objective accuracy is the provision of transparency and credibility regarding the research process, which is intended to demonstrate to readers how findings were derived and how the phenomena were identified. The researcher has also been aggressive in either eliminating research bias through bracketing and considering multiple viewpoints or, where necessary, explicitly identifying bias. This will help identify where the findings may be influenced by existing biases. The researcher believes that the validity and accuracy of the results was confirmed as a result of using these approaches.

Limitations

Although the research design was implemented using substantial critical thought and review of literature regarding the existing theory and practice of phenomenological research, there are, as with any research design, limitations that cannot be eliminated from the research process. First, there are fundamental limitations particular to qualitative research. As outlined by the discussion of Ricoeur, the phenomenological method put forth by Husserl (as based on philosophies of Hegel and Heidegger) has a number of contradictions and conflicts within its internal philosophy that must be taken into account when analyzing and examining the data provided. One of the most basic of these contradictions is the implication that a phenomenon is both shared and personal. A second of these contradictions is that a phenomenon must be described based on physical experiences. These conflicts and contradictions might have challenged the researcher and thus led to incomplete or inadequate derivations of essence from the phenomena.

As noted above, a variety of methodological difficulties might have occurred in the research, including failure within the bracketing or imaginative variation processes, failure to derive meanings that participants agree with, or other potential failures of information or analysis. To help prevent these failures, the researcher used a constant process of checking and re-checking critical analysis of interpretations, and he particularly focused on ensuring that the transcendental interpretations of phenomena and essence were consistent with the natural understanding of the respondents.

There are also more general limitations of the research that are shared with other qualitative methods. First, there are limitations in the significance of qualitative research based on the commonly small sample size and the lack of representativeness in the sampling approach.[57] These limitations obviously include restrictions on statistical significance (which do not exist, given that statistical methods were not used), but can also include limitations on practical significance of the findings, particularly if the sample is small and does not represent a wide view of the situation. To overcome this problem, the researcher selected participants from a range of different educational backgrounds, generations, organizations, and geographic regions in order to reflect a range of architectural pedagogy methods and approaches. Overall, a wide array of opinions and

[57] Anthony J. Onwuegbuzie and Nancy L. Leech, "Enhancing the Interpretation of 'Significant' Findings: The Role of Mixed Methods Research" *The Qualitative Report* 9, no. 4 (2004): 775–776.

experiences is reflected in the sample, suggesting that the problem of limitation of the broad view was not an issue.

Another concern in qualitative research is that of researcher bias because such research draws more on the fundamental views of the researcher as compared to quantitative research.[58] As Creswell and Miller explain, this is not necessarily a conscious bias, but instead can result from paradigmatic assumptions and unquestioned worldviews of the researcher, which could impair the ability to see specific issues and cloud the analysis. The bracketing process of the phenomenological approach was intended, in part, to overcome this issue. There are also a number of other approaches that can be used to overcome researcher bias, including triangulation, disconfirmation (seeking out evidence that a finding is not true), member checking, and thick description (detailing every aspect of a given phenomenon), according to Creswell. This research did not make use of triangulation (except in terms of triangulation between participant inputs), but did apply disconfirmation, reflexivity, member checking (i.e. confirming interpretations with participants), and thick descriptions. These approaches were intended to reduce (although they cannot eliminate) researcher bias.

It should be noted that the phenomenological approach is not often represented in the existing body of architectural research since most phenomenological architecture studies focus on understanding the phenomena of space, home, or environment. Nonetheless, while this rarity is a clear feature of the research, the researcher does not believe that it represented a limitation. First, the research is not on architecture *per se,* but

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[58] John W. Creswell and Dana L. Miller, "Determining Validity in Qualitative Inquiry," *Theory Into Practice* 39, no. 3 (2010): 125.

is instead focused on architectural pedagogy. Architectural pedagogy serves as a framework for philosophies of knowledge, learning, knowledge generation, knowledge alteration, and knowledge transfer within the field of architecture. This research focuses on the role of technology in this area. As such, the research as designed is closer in nature to educational research than to the existing body of architectural research.

Phenomenology is not the most common approach in educational studies, but it is more common than in architectural research. More importantly, however, the researcher believes that the use of phenomenology presents a fresh perspective on architectural pedagogy and its connections to the past, present, and future, as well as providing an understanding of the context and shared experience of the phenomena identified.

The Grounded Theory Stage

This research applied a grounded theory approach to a focused qualitative study aimed at identifying a specific theory of how advanced technological paradigms are shaping architecture and design pedagogies. This grounded theory was built on the outcomes of the phenomenological data analysis, as described above. It used the narrative and thematic outcomes as a means of achieving a theory regarding the target phenomena identified in the research.

This section focuses on providing an insightful understanding of the grounded theory approach used in this research. The theory has become increasingly more common in the body of inquiry over the past two decades, mainly because of the complex nature of data studies and the need to re-shape hypotheses depending on the results of the data collected. Creswell argues that "grounded theory development does not come off the shelf, but rather is generated or grounded in data from participants who have experienced the process."[59]

Figure 7 shows the simplified process of grounded theory (following Charmaz 2006) that was used for this research. In this case, the same data derived for the phenomenological study was used as data for the phenomenological analysis. This process is Stage 2 in Figure 4, which shows the fully integrated research approach.

[59] John Creswell. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches.* (London: SAGE, 2011), 83.

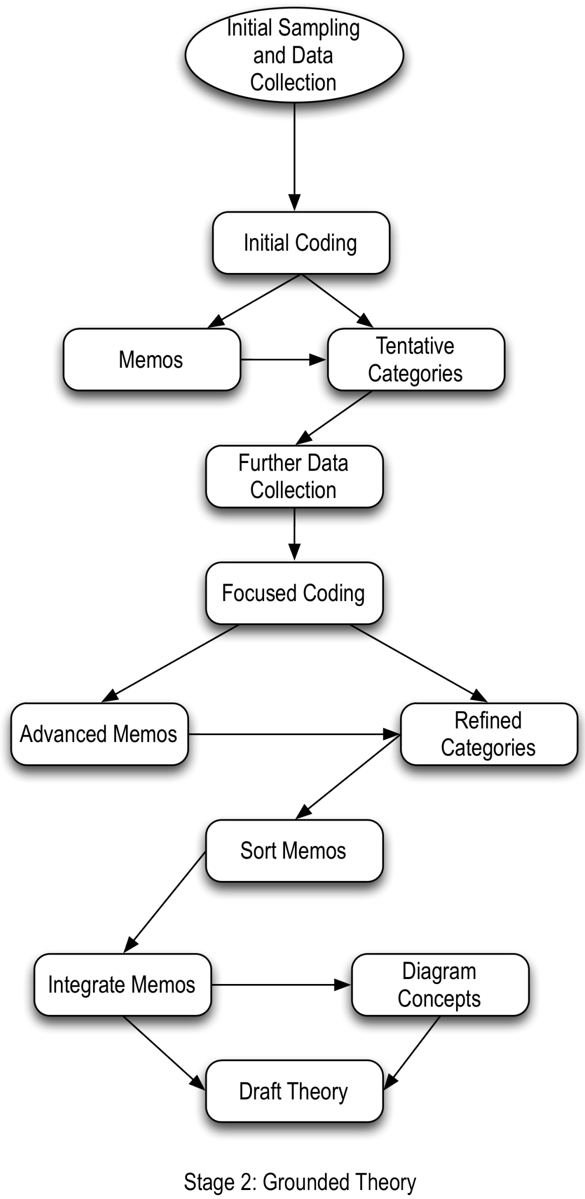

Figure 7. The Second Stage of Research (Grounded Theory).

Grounded Theory: A Definition

Grounded theory research, introduced by Glaser and Strauss, is a qualitative approach to theory formation.[60] Creswell defines grounded theory as "a qualitative research design in which the inquirer generates a general explanation of a process, an action, or an interaction shaped by the views of a large number of participants."[61] Richard Swanson observes that this is a reversal of the usual process of research. According to Swanson, "The term *grounded* refers to the systematic generation of theory from data that has been empirically collected and analyzed. It is, thus, the creation of theory that is based on data from fieldwork."[62] Charmaz presents a very similar definition of grounded theory. She states that "essentially, grounded theory methods consist of systematic inductive guidelines for collecting and analyzing data to build middle-range theoretical frameworks that explain the collected data."[63] A condensed definition of grounded theory is that it is an inductive research process in which the researcher builds his or her theory from analysis of empirical data collected from the field (as from participants or observation).

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[60] Charmaz, "Grounded theory," 509.
[61] Creswell. *Qualitative Inquiry*, 83.
[62] Richard Swanson, *Research in Organizations: Foundations and Methods of Inquiry* (San Francisco: Berrett-Koehler Publishers, 2005), 266.
[63] Charmaz, "Grounded theory," 509.

Reasons for Using Grounded Theory

It is likely the fact that grounded theory acknowledges the complexity of qualitative research analysis that has led to its success and popularity in recent social research. Charmaz notes that “grounded theory methods foster seeing your data in fresh ways and exploring your ideas about the data through early analytic writing. By adopting grounded theory methods, you can direct, manage, and streamline your data collection and, moreover, construct an original analysis of your data.”[64] It also provides researchers with a model that does not require an initial hypothesis or a theory, subverting the traditional research style. This is important when studying issues that have not been studied before, those that rely heavily on qualitative data, or those where the nature of the study makes it difficult to predict a hypothesis for testing.

Limitations of Grounded Theory

As with any single research methodology, there are a number of limitations associated with the grounded theory approach. Clive Seale argues that grounded theory is inappropriate for some problems, such as those where there is an established body of theory.[65] Moreover, theoretical disputes often emerge with regard to grounded theory. Charmaz notes that “postmodernists and poststructuralists dispute obvious and subtle positivistic premises assumed by grounded theory’s major proponents and within the

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[64] Charmaz, *Constructing Grounded Theory*, 2.
[65] Clive Seale, *Researching Society and Culture* (London: SAGE, 2004), 245.

logic of the method itself."[66] (These premises include the assumption that reality is objective, enabling the establishment of a single theory from observation.)

Despite these limitations, Charmaz argues that "grounded theory can provide a path for researchers who want to continue to develop qualitative traditions without adopting the positivistic trappings of objectivism and universality. Hence the further development of a constructivist grounded theory can bridge past positivism and a revised future form of interpretive inquiry."[67] Following this observation, Charmaz suggests that the nature of grounded theory and its reliance on the researcher's interpretation of the data ensures that it is best suited to a research paradigm of interpretivism as well as the use of a qualitative research methodology (though this is not required). Because grounded theory research usually utilizes qualitative methods and fails to identify meaning until the data is collected, it is difficult to assume that studies using the theory can be positivist in their outcome.

Use of Historical Data

There is a common misunderstanding that a grounded theory approach does not make use of previous research, either historical or methodological, until the interpretive stage.[68] This misconception is understandable since the seminal research by Glaser and Strauss, as well as much grounded theory work that has taken place since that time, prioritized primary research rather than first seeking out detailed theoretical frameworks.

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[66] Charmaz., "Grounded theory," 510.
[67] Ibid., 523.
[68] Bryant and Charmaz, *Handbook*, 500.

Yet, this does not necessarily have to be the case. In fact, grounded theory is routinely backed by established social science theoretical frameworks as pointed out by Bryant and Charmaz. For example, Marxism and neo-Marxism, which apply an economic lens to social and humanities studies, are commonly drawn upon in qualitative social research. If grounded theory lacked reference to previous research or historical context, that would make the theory ineffective for current research. Luckily, this is not the case. Instead, historical and empirical research pose a substantial benefit to the method because grounded theory helps to build the context in which the research can be placed. Bryant and Charmaz describe the relationship between grounded theory, historical, and empirical research as follows:

> Grounded theory is a performance, a set of performative and interpretive practices and ways of making the world visible. This commitment to visibility is anchored in the belief that the world, at some level, is orderly, patterned, and understandable. The world of social interaction and social experience can be theoretically sampled, saturated, located in a situational social world, arena mapped, coded, fitted into conceptual categories, diagrammed, placed in conditional and consequential matrices, and represented in narrative, visual, and historical discourses.[69]

Understanding the historical and empirical origins of pedagogical approaches, as proposed, is both consistent with and vital for building a contextual understanding of the research questions. This integration of knowledge will lend historical and social context to the knowledge of the interviewees, particularly given that there is a direct lineage of technology-influenced pedagogy that only reaches back a few generations. In this way, a historical perspective is not only appropriate, but also absolutely relevant to the approaches used to study contemporary architectural pedagogy. These historical antecedents must be understood in order to make sense of the current attitudes regarding

[69] Ibid., 501.

the machine and its place in architecture. Thus, the integration of historical research into architectural pedagogy and philosophy, as well as rich description of various empirical research topics, are entirely appropriate and therefore have been integrated into the research process.

Grounded Theory Process

The process of grounded theory is, at first glance, fairly complex. The research method begins in a fairly straightforward manner but becomes more and more complicated as the process continues. As stated by Charmaz:

> Grounded theorists start with data. We construct these data through our observations, interactions, and materials that we gather about a topic or setting. We study empirical events and experiences and pursue our hunches and potential analytic ideas about them. Most qualitative methods allow researchers to follow up on interesting data in whatever way they devise."[70]

That is, the first stage of research is the collection of data, a stage that traditionally comes later in the research process. This highlights how the grounded theory method is different from most research approaches and shows that the design of the research is not as crucial to the end result as is the data that is collected.

Following data collection is the data analysis phase, which consists of a number of sub-stages. Charmaz stresses that "as grounded theorists, we study our early data and begin to separate, sort, and synthesize these data through qualitative coding. Coding means that we attach labels to segments of data that depict what each segment is about.

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[70] Charmaz, *Constructing Grounded Theory*, 3.

Coding distills data, sorts them, and gives us a handle for making comparisons with other segments of data."[71]

Coding is a significant component of the grounded theory process, which effectively assists the researcher in categorizing, classifying, and scaling down the sizeable amount of collected data. The first stage of coding involves making memos, which encode comparisons and ideas that occur during the research.[72] Memos serve to define tentative coding categories for further analysis. The researcher can use the initial coding stage as a series of possible reminders, ensuring that, in the following data analysis and further data collection, gaps in the research can be addressed; it is these types of information that are recorded in the memos. Through these memos, the researcher is able to begin to establish categories and fit units of meaning derived from the coding process into them.

Once initial categories have been decided, the research becomes gradually more theoretical in nature. At this point, researchers may "return to the research participants to learn more and to strengthen our analytic categories. As we proceed, our categories not only coalesce as we interpret the collected data, but they also become more theoretical because we engage in successive levels of analysis."[73] It is at this stage that the final part of the process takes place, the emergence of the grounded theory. Charmaz highlights that the analytic categories created—and the relationships that can be drawn between them—help to build a theory by repeatedly layering data, refining analysis, and adding

[71] Ibid.
[72] Ibid.
[73] Ibid.

further data.[74] Here, Charmaz portrays the grounded theory approach as one of layers. The researcher continually adds layers of analysis until the grounded theory is established.

In summary, a grounded theory approach consists of two main processes: data collection and coding. Data is initially collected without any specific research question or theory in mind. During data analysis, the researcher repeatedly refines the data through coding and may re-question the participants or obtain more data depending on the perceived needs of the study. This continues until abstract themes and relationships emerge, thus creating the grounded theory. This grounded theory is used to formulate future research designs.

The diagram below, proposed through the work of Charmaz, attempts to show the semi-cyclical process of the grounded theory approach. It is clear from the diagram that the coding stages and those involving data analysis can generally be repeated a number of times, essentially until the researchers are confident that the abstract nature of the study has been defined and until they have enough data to highlight a research problem and complete a study on it.

[74] Ibid., 4.

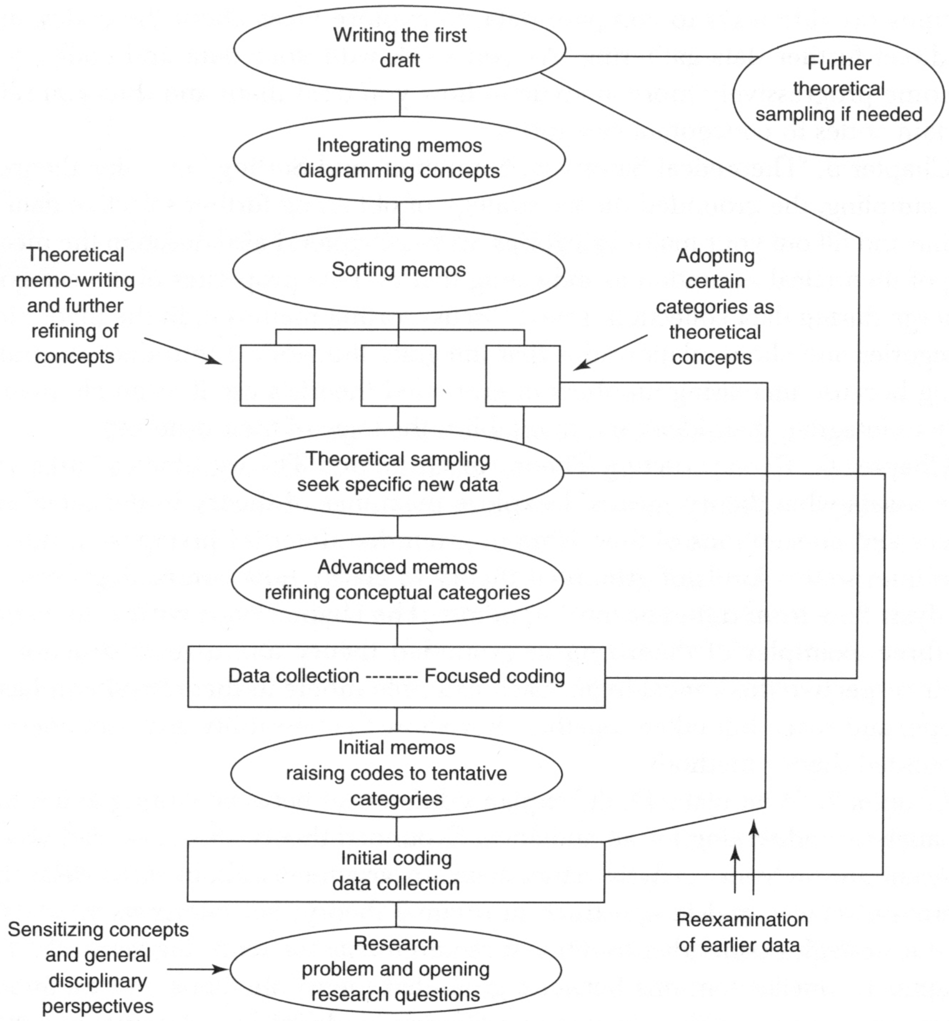

Figure 8. The Grounded Theory Approach Process.[75]

Coding

The coding process is vital to the grounded theory approach. Charmaz asserts that "analysis begins early. We grounded theorists code our emerging data as we collect it."[76] The entire research process relies on the use of coding, and its importance cannot be

[75] Ibid., 11.
[76] Charmaz, "Grounded theory," 515.

overstated. The importance of coding, particularly since it shapes the entire grounded theory study and its focus, is not lost on scholars that utilize this method. Charmaz argues, "Unlike quantitative research that requires data to fit into preconceived standardized codes, the researcher's interpretations of data shape his or her emergent codes in grounded theory."[77]

The first phase of coding is the initial coding stage, or "open coding," which involves defining actions or events from each line of data to extract views of participants.[78] In subsequent phases, it is vital that continual data analysis and subsequent layered coding occur, with the researcher comparing data provided by participants and searching for possible relationships and emerging themes from the data. In addition, grounded theorists are able to continually seek new data from participants in order to help answer questions that may have emerged from the initial coding. At each stage of coding, themes become more definite and focused (as well as potentially more theoretical) until the researcher emerges at a theory. The nature of coding as a central process of grounded theory is perhaps the most unusual part of the entire approach and one that singles it out from others that are more restricted by pre-agreed codes of inquiry.

An example of the coding process that was used in this research is the codes related to space and time dimensionality. The open coding process identified all statements related to space and time, coding under broad categories such as time, space, scale, dimensionality, and physical skills, as well as other categories that were related (such as building and simulation). No specific guidelines or codebooks were used during this process. Following the completion of coding for all interviews, the resulting codes

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[77] Ibid.
[78] Ibid.

were compared, and those that were clearly identical were collapsed into a single unit. After this, the codes were grouped into categories that reflected close relationships of complementarity or opposition between the codes. In this case, time, space, scale, and drawing skills were associated under a single category of physicality because they were primarily associated with the way in which students and pedagogies relate to the physical world. Other codes in this category included embodiment, mediation, physical skills, and visualization. Building and simulation categories, however, were moved to the design studio category because these were discussed more in the process of creation and experimentation within the studio rather than in terms of basic perception. This process was recreated for each code and category, with the ultimate analysis having 76 codes in nine different categories.

An Analysis of Memo-Writing

Figure 8 emphasizes the importance of memo writing within the process of grounded research. Memo-writing should be conducted after the initial coding has taken place and throughout the data analysis stage of the research. It is stated that "memo writing is the intermediate step between coding and the first draft… . It can help us to define leads for collecting data—both for further initial coding and later theoretical sampling… . Memo-writing leads us to explore our codes; we expand upon the processes they identify or suggest."[79]

[79] Ibid., 517.

For the researcher, the complex nature of the data analysis phase means that continual questions need to be asked of the data collected and coded. Through the use of memos, the researcher is able to look at the data in new and enhanced ways, ensuring that the process of data analysis and coding continues to iterate and develop toward a completed theory. Memo-writing was undertaken using the annotation function in HyperResearch and paper notes within the interview transcripts. An example of memo-writing that related to the physicality category (used as an example for coding above) is that "embodiment" was annotated with a memo that referred to Marshall McLuhan's notion of media as a servo mechanism, wherein the uses of the body are severed and divorced from the body. It also included a second note that explicitly tied it to the mediation category. (Mediation did not play a significant role in the final analysis, however, as it was a point discussed by only a few interviewees and did not offer significant depth.)

Constructing a Theory within the Grounded Theory Model

One of the main proponents of the grounded theory, Glaser, notes that it is important for theories emerging within grounded theory research to be truly grounded, rather than derived from previous concepts. It is necessary to point out that "grounded theorists cannot shop their disciplinary stores for preconceived concepts and dress their data in them. Any existing concept must earn its way into the analysis."[80] This belief highlights the importance of the final stage of the grounded theory process, the

[80] Ibid., 511.

construction of a theory within the grounded theory model and why it is crucial for researchers to continually assess data until the information is at an appropriate level to become theory. In particular, the information must be abstract and general rather than particular to be considered a theory.

There are key aspects of a reconstructed theory. These elements include that the grounded theory "must work" by providing a conceptual framework that explains the phenomena and also that the theoretical categories should fit this analysis. [81] The researcher should not attempt to take shortcuts, which can result in theories that are not truly derived from the data. The importance of grounding the theory in the observed data makes the data collection stage particularly important.

Grounded theory is appropriate for use by researchers who are unsure of the results that will be obtained by their methodologies, or particularly those who do not want to presuppose the outcomes of their research. Primarily used as a research design for qualitative studies, the approach allows researchers to conduct the data collection stage first and then use the data collected to help create themes and categories that can then be transformed into an abstract theoretical understanding of the phenomenon under study.

One of the key strengths of grounded theory is that it enables the researcher to postpone the formation of a theoretical framework, instead moving from the particular case to the general instance. This allows more openness in discovery from the research process, especially compared to studies that are tightly focused on achieving a specific aim using a specific theoretical framework. It also avoids imposition of an inappropriate

[81] Ibid.

theoretical framework on the data. There are some limitations to grounded theory, including the need to find specific evidence within the data for a given theory and the potential for overlooking or unnecessarily refining a theory. These limitations are consistent with those found in other frameworks and therefore should not discourage a researcher from using the grounded theory process. Overall, among the grounded theory method's strengths are that it enables observation-first discovery of knowledge and that it is not bound by (sometimes inadequate) existing theoretical approaches. These strengths make it ideal for the closure stage of this research.

Example of the Process

To demonstrate the overall process, one of the interviews performed has been deconstructed using the overall flow chart for the research (Figure 4). This process traces the interview with David Gersten, who offered one of the most prolific and helpful interviews conducted.

The process is divided into seven stages:

1. Gersten was identified as a potential participant and was contacted via e-mail to determine whether he would be willing to participate. The requirements and goals of the interview were explained. When he accepted, a time and place was set for the interview.
2. A single in-depth personal interview that lasted slightly over two hours. The interviewer used an interview guide, but also followed up on areas of interest. The interview was recorded.

3. The interviewer then transcribed the recording and followed up with Gersten regarding questions about accuracy of quotes and to gain further information. The transcript was hand-annotated and then annotated using HyperResearch.
4. During this stage of the phenomenological analysis, the researcher:
    a. Bracketed his assumptions about technology (particularly about its utility and the uses of technology, which were highly relevant to Gersten's interview).
    b. Sorted the units of meaning, first by response and then by breaking down responses to distinct statements and opposing statements.
    c. Identified *essential* elements of each phenomenon posed (such as scale and physicality) using a process of phenomenological reduction, along with inputs from other interviews describing the same thing.
    d. Compared the phenomena to existing literature and marked information for future member checking.
5. The grounded theory analysis progressed similarly:
    a. Initial coding and categorization, accompanied by memo-writing
    b. Integrating information from other interviews
    c. Refinement of categories; advanced coding and memoing
    d. Establishment of a tentative theory
6. E-mails and telephone calls were used to clarify information and seek out more information during the coding process.
7. On completion of the phenomenological and grounded theory analyses, member checking was used. In this case, an email to Gersten was used to describe the

theories and phenomena derived, and adjustments were made based on his feedback. The same process was used for each of the interviews, and the grounded theory and phenomenological analysis integrated feedback from all participants

CHAPTER 4: FINDINGS

A combination of phenomenological analysis and grounded theory has been used to analyze the information provided by various participants in the research. This chapter presents the findings of this analysis. The findings are arranged according to research questions, all of which were outlined in Chapter 3, *Interview Guide*. The chapter begins with an introduction of the research participants and then discusses the epistemologies identified and their historical connections. These historical connections are not strong, mostly unremarked, and based in superficial similarities rather than extensive derivation. The second point of discussion is a critique of the pedagogy used within the schools, especially the integration of advanced digital techniques and paradigms. The third point of discussion in this chapter is the diverse views of the future that the participants offer, which range from technologically determined to extensive and pluralistic.

Participants

This research is based on 18 interviews with faculty members at various leading schools of architecture around the United States. These participants engaged in a single interview each, including a mixture of video calls via Skype and in-person interviews. In-person interviews were preferred for most participants, with Skype interviews being used only in cases where in-person interviews could not be arranged. The interviews ranged in length from around 55 minutes to approximately two hours. The participants in the study have a variety of both academic and professional qualifications in architecture, enabling them to offer multiple views on the subject of technology (see table 2 in Appendix A).

Historical Connections

One of the most important insights is that historical connections are *not* explicit in the responses of individuals or the general knowledge base used by school curricula. Superficially, many of the programs look similar to the programs put into place by the Bauhaus or Vkhutemas, with the use of workshops and design studios in which students work with specific skills or materials. In a few cases, there are also first-year survey courses that are similar to the Bauhaus Foundation or the Vkhutemas Basic Division courses (for further information see Chapter 2, the curriculum and pedagogy of the Bauhaus and Vkhutemas sections). According to Ronnie Parsons, the Pratt Institute continues to use the Foundation course model. However, he also rejects that this is a direct link to the Bauhaus school of design in terms of epistemology or ontology. Instead, he argues that knowledge is situated in technology and culture and that the Bauhaus model of information is inappropriate for the contemporary world. Parsons remarks:

> *What I'm saying, though, is that to assume that you would still today need to work through a model that is actually from an entirely different point of cultural time is a little bit crazy to me. Because that makes certain assumptions about the intelligence that exists today, which is radically different than the intelligence that exists then, right? So, models of design ideation and conception today are completely different because culture information technology today is totally different.*

This rejection of the historical basis of the curriculum is not universal. Bruce Lindsey, from the Washington University in St. Louis, noted that the Bauhaus curriculum design was particularly strong at his university from the 1950s through the 1980s, although its influence has since faded. He related that an influential faculty member had attended the Institute of Design in Chicago, so both the design ethos and curriculum of the Washington program were particularly strong because of this. He notes that the Bauhausian influence continues with the establishment of the Sam Fox School, which is intended to integrate architecture and art. The Washington program also continues to use a freshman foundation course inspired by (though not directly informed by) the Bauhaus Foundation course. This course, arranged by one of the strongest proponents of digital technology in the school, is now heavily influenced by digital technological paradigms. Thus, although geometric studies and other elements of the Bauhaus Foundation course do persist, the basic Washington course is also highly informed by more contemporary curriculum technologies and inspirations.

There is limited evidence of ideas remaining from the Bauhaus period. Elizabeth O'Donnell (Cooper Union) suggests that ideas of space and form are the *"most Bauhausian idea that remains at Cooper Union,"* with most of the curriculum being brought forward to account for digital technologies and other changes. Given that Cooper Union is one of the most traditional of the programs surveyed (for example, continuing to teach hand-drawing), this is a powerful statement about how little explicitly remains from this period.

Some of the interviewees actually feel that an emphasis on historical pedagogical methods from the Bauhaus (or other theoretical inheritances) was somewhat negative. For example, Jason Johnson (California College of the Arts) feels that schools could move beyond discussion of the Bauhaus in history and critical theory courses to discuss systems theory, networks, and other issues of particular concern to the contemporary teaching environment. Perhaps one of the key observations in this area comes from William McDonald (Pratt Institute), who notes the following about the Bauhaus in comparison to today's architectural pedagogy as practiced at his school:

> *[The Bauhaus] had sort of craft material professor along with a design professor. So they both involved themselves in terms of theory… . I would say it's less of a separation and that it was at the Bauhaus where you had sort of an expert in this and an expert in that. You put them in a studio, and then they [would] . . . provide a kind of combination. Rather than that, I would say that there's already a very fluid relationship between digital design practices that come from the design wing and computational experimentation, which comes from the computer wing.*

McDonald's suggestion that the Bauhaus modality of craft and design separation has been integrated has some merit, although the continued separation of practice (design studio) and theory (seminar) suggests that this integration may be overstated. Another possible reason for the lessening of importance of the curriculum ideas of the Bauhaus in the contemporary architectural pedagogy is the ethical role of technology in the social project of architecture. About the role of technology, Nader Tehrani (MIT School of Architecture and Planning) states:

> *In modernism we've seen the way in which technologies heralded at the theoretical level from mass production and the changing and democratization of society… . But, I think, ironically technology is not only instrumentalized; it's also abused… . So, for me the element of cultural criticism and the context in which technology is manipulated is as important as the instruments of technology.*

In Tehrani's view, then, the seminar component (notably lacking from the Bauhaus model) would be key to criticizing the role of technology and its context of use. Mohsen Mostafavi (Harvard University) also emphasizes the importance of technology in social conditions, but notes that social situations are *not* the most important aspect of the curriculum. Instead, he argues, *"We believe in the idea of design leadership and design excellence through societal engagement, this idea of engaging society with design. We are not a social study school; we are a school of design that believes in societal transformation through design."*

An overall assessment of the historical connections of the epistemologies and pedagogical methods in the schools surveyed is as follows. First, there are historical connections to the constructivists (see the historical pedagogies at the Bauhaus and Vkhutemas in Chapter 2), though they may not be deep connections, in three areas: 1) the concern with social and ethical practices; 2) the Foundation course, which included study of geometry and design elements; and 3) the emphasis on technologies and materials. This relationship is not uncontested. No school would today admit to having a curriculum entirely defined by Bauhausian ideals or design features; the influence is either inherent (such as integrated into the assignment structure) and unremarked, or is negative (such as the rejection of separation of design and theory elements of architecture). Thus, the historical connection to the Bauhaus is present, but it is limited in its conscious recognition and is often more an issue of critique rather than continued integration of practices and methods.

Epistemological Foundations

There are a number of different aspects of the epistemological foundations of learning that can be highlighted in the discussions offered by the participating faculty members. These epistemological foundations describe the ways in which professors construct an understanding of the task of learning and define what the purpose of learning is. Key issues in the epistemology of the architecture classroom as identified by these participants include diverse paradigms, understanding the nature of the problem, integrating the total human experience, the physicality of design, finding a balance between design rigor and design intuition, and finding a balance between theory, critical thought, and design practice.

Teaching Paradigms

Something that was clear in most cases is that teaching paradigms within the schools are mixed and are not set by standards or shared curricula. Most participants did not name a particular teaching paradigm or model that was used in their schools, although if prompted they often agreed that a given paradigm (such as network theory) was in use by at least some professors. Overall, the interviewees feel that the paradigms in use in the classroom are dependent on the preferences of the instructor as well as, to some extent, the preferences of the studio project selected for that semester. Bruce Lindsey (Washington University, St. Louis) describes his program's philosophy:

> *I would say it's not an explicit theoretical framework. I think the work that we've been doing in the last few years has been centered on working with the students to be able to use the computer to get things out into the real world, in other words to make models, fabricate, and to explore full-scale projects. Prior to that, I would say the school, like many other schools, was using digital technology primarily in the area of digitalization, but also with the last couple of years we've developed several new classes and several focus studios on the role of environmental simulation and the analysis of building performance using software tools.*

This was similar to the statements made by many of the participants, who simultaneously indicated that there was no explicit theory that was used, but also indicated that technology is inherently integrated. This suggests a lack of critique of the role of technology in the pedagogy (although it is clear that this critique does occur in other design areas). In many cases, there was an explicit statement that digital technologies and traditional methods were integrated into the same teaching paradigm. For example, Mohsen Mostafavi notes that digital technologies, such as 3D printing, were used alongside traditional techniques, such as hand-drawing, with the task rather than the tool determining what should be done. Ronnie Parsons specifies that, in addition to the integration of traditional and digital design techniques, there is also integration of design critiques and critical thinking about the purpose of design into the curriculum. The purpose of this integration is spelled out by Nader Tehrani, who notes, "*I don't see that we have a single paradigm informing the uses and abuses of technology, precisely because we see technology as a malleable medium. It's not an end; it's a vehicle by which to research.*"

Thus, the overall position toward teaching paradigms expressed by the participants is that they are diverse and that, furthermore, the particular paradigm, theory, or technological method in use is more of an instrumentality than a real focus of concern. To a large extent, it is the process that is more important than the theory in this case, which represents a fundamentally pragmatic philosophical viewpoint.

Understanding the Nature of the Problem

One of the most extensive categories of discussion offered by the participants is *understanding the nature of the problem*, which was seen as the primary task for teaching and learning within the architectural academy by many participants. Phillip Anzalone (Columbia University Graduate School of Architecture, Planning, and Preservation), describing why he teaches students to perform calculations by hand, remarks:

> *I mean, as an example, a very specific example, a lot of the tech courses I teach, if you do an analysis of a problem, if you don't understand the fundamentals of what the problem is, the analysis isn't gonna work. It's garbage in, garbage out theory right? If, let's say, we're doing analysis of the wall and how the sun is coming in, and the computer can do the billion calculations and tell you what's the most efficient—but if you don't understand even what it's giving you, much less how you set up the problem, then you may not get the answer. How are you guaranteeing you're getting the right answer to the problem?*

In other words, Anzalone is very concerned about students not just solving a problem, but solving the problem they are meant to solve. This suggests that the critical skill inculcated by architectural pedagogy is not solving a problem (technically very easy in many cases, especially with technological assistance) but instead lies in understanding the problem that must be solved. This quote neatly demonstrates and encapsulates the problem that many of the participants see: It is very easy today to teach people to arrive at an answer to a problem (such as generating the answer to an equation or a parametric design) without truly understanding what the problem implies.

Evan Douglis (Rensselaer School of Architecture) agrees, arguing that if a student is using a script to solve a particular problem, then the student should be able to explain what the script is doing. In other words, the script should be a convenient tool rather than a black box. David Gerber states, "*I always like to say the computer is stupid, and you as a designer need to be able to control your tools, whether it's the pencil or the mouse or the algorithm.*"

Another permutation of this problem is what the effects of the given experiment are in reality. For example, many of the participants mentioned the ability to use sliders to change sizes or other attributes in a Rhinoceros 3D or other design file format. They noted that while the technology could be used to change the size, this did not provide an answer for what changes were made in the design and what these changes meant for reality.

Jason Johnson notes that problems such as building performance can be easily simulated using technological tools, but these tools do not offer information into what the right simulation is; instead, the designer needs to choose a configuration that meets the needs of the building. This is supported by Omar Khan (University of Buffalo School of Architecture and Planning), who notes that Grasshopper (a graphical algorithm editor runs within Rhinoceros 3D CAD modeling tools) lets the designer easily change configurations but leaves the final choice up to the designer. Thus, designers need to make a technical and aesthetic judgment, no matter what the eventual design features are.

David Gersten (Cooper Union Irwin S. Chanin School of Architecture) extends this argument from technology to ethics, noting that we need to look beyond what technology can and cannot do to understand what should and should not be done (whether it is technically possible at the moment or not). He states, *"The hardest part is the necessary. Where's the voice of that, meaning how do we even sort that out? Technology does not give us the questions or the tools or the framework within which to* *ask what's necessary. That's human; that's ethics. It prefigures technology."* Thus, understanding the ethical nature of the architectural problem in reality, as well as its technical effects, is also part of this theme of understanding the nature of the problem.

Jason Griffiths (Arizona State University, Herberger Institute for Design and the Arts) illustrates this point brilliantly with an anecdote about an early use of technology:

> *My old teacher many years ago—called James Gowan, who's in partnership with James Stirling—was confronted with one of the students who was developing a fly-through model just using Form-Z at that particular time. And everybody was amazed that this guy had managed to do a fly-through model, and his first question before he saw it was, "Are the spaces worth flying through?" You see, and it's absolutely a fundamental question.*

Once again, Griffiths meets the basic problem: What is the problem to be solved? The position in regard to technology as a tool of design and the need to understand the nature of the problem is not uncontested. Jason Gerber (University of Southern California) notes that there is a need for synthesis in design, which prevents the complete derivation of design from an algorithm. Thus, design problems are in fact very complex, and completing the design requires the use of the technology. This is in opposition to the previous statements from him about teaching students to solve the basic problems by hand. (This does not absolve the designer from understanding what the problem is that they are trying to solve!) Regardless of the necessity of technology in some architectural design scenarios, most interviewees stated that technology was a tool for design, not a means of selecting the design. All participants who addressed the issue made it clear that the human architect, not the technological tool, is the one that makes the final selection of a design solution.

Overall, participants focused on the core role of understanding what the nature of the architectural problem is, whether that problem is aesthetic, technical, or ethical. They emphasized that this problem cannot be solved by technology, but must be a human judgment call based on knowledge (although Gerber did concede that some technical problems are too complex to be solved other than algorithmically). Ultimately, as Ronnie Parsons states, designers have to be able to explain *why* they selected a certain design. This is something that the use of technology cannot provide, and it is a core element of the design curriculum and a big part of what the participants viewed as their role as teachers.

Total Human Experience

Much of the epistemological foundations of the research can be viewed under the guise of what Erich Jantsch describes as "total human experience," or the integration of sensual and intellectual knowledge and other forms of experience and information along with social norms and forms. Gil Akos (Pratt Institute), reflecting on his own time in architectural school, states:

> *One of my professors when I was in school . . . told me, subsequently after letting me try and fail in a bunch of things, that the curriculum was not intended for three months, but for three years, because . . . you can really only understand a lot of elements of contemporary technology and their implications over that amount of time and trial and failure.*

Thus, the pedagogy of the architectural school is based on a foundation of learning through experience and building understanding through failure, which leads to a gradual accumulation of knowledge and understanding of design and technology over time.

Evan Douglis also emphasizes the importance of experience, noting that the architectural vision of the individual designer was acquired by *"having experiences within your architectural education, which are different and varied and sometimes even found in antithetical or in great juxtaposition to each other."* Omar Khan described a program structure where knowledge built up until, by the third year, systems knowledge (which is the third element in Jantsch's program) was the focus of learning. A similar structure is described by Mohsen Mostafavi, who notes that the first two years of the core program are followed by branching out and students following their own interests. The goal of this flexible structure is that "we actually want to create difference."

The form of Jantsch's suggested curriculum is also evident in many of the remarks by participants. For example, Douglis notes that experiences are both top-down and bottom-up and integrate learning at several different social levels, rather than taking place all at one level. Thom Faulders (California College of the Arts) re-emphasizes Jantsch's point about the individuality of the learning process by noting that the curriculum of his program enables students to have sets of differing experiences. David Gersten stresses that technology is inadequate to resolve all problems; he argues,

> *The spectrum of questions far exceeds the question of technology. I mean it's obvious: I don't think a rational person could say that the spectrum of the questions of the human condition at this moment can be solved by technology alone. I think you have to be kind of delusional to think that. It requires a spectrum, and that doesn't mean that more technology is bad at all.*

Thus, the role of technology is conflicted since it is not the only tool (just as, in Jantsch's argument, knowledge is not the only tool that can be used to solve problems). At the same time, resolving problems that result from technology requires a wide range of experiences and skills. Gersten argues that evolutionary knowledge and diverse forms of knowledge are required to support development of design skills. This is clearly connected to the next tenet of the epistemology expressed by the interviewees, that of multidisciplinary learning.

Multidisciplinary Learning

Since multidisciplinary and interdisciplinary learning is a centerpiece of Jantsch's model curriculum, it was important to find out if this is an aspect of the actual curricula being used today. The role of multidisciplinary learning is more conflicted than many of the tenets of epistemology. Some interviewees reported interdisciplinary learning within what could be termed the core fields, such as urban planning or computer science. For example, Skylar Tibbits (MIT School of Architecture and Planning) describes that the M.Arch program might include "history, theory, computation, urbanism . . . [as well as] computer science [and] design computation" in the theoretical classes, plus a range of design courses from traditional studio courses to fabrication and other types of workshops. Phillip Anzalone notes that structural dynamics, strength of materials, solar geometry, and other scientific aspects of architecture are something that he teaches in his Architecture Technology I course, which is designed for students without an architecture background (or in some cases without an undergraduate degree). Thus, within the architectural discipline itself, there is a range of interdisciplinary options that could be selected by the students. Anzalone notes that there is also a cross-pollination of technological tools and information between related disciplines, such as industrial design and aeronautical design. Thus, this form of multidisciplinarity extends beyond the classroom.

A second form of interdisciplinary or multidisciplinary study is that which draws from outside the architectural and related disciplines. For example, Ronnie Parsons notes that computer science, mathematics, and biology all play a role in architectural learning at Pratt. Furthermore, he argues that shared interests in simulation and other aspects of design mean that the interdisciplinary learning is a two-way relationship, not simply something that architecture draws from other disciplines. Faulders points out that information about social sciences, such as population, energy, and other concerns, is required within the curriculum, in addition to the architectural trade craft. He argues that this knowledge is required to understand and solve social problems. Once again, understanding the nature of the problem comes to the forefront of the pedagogical intention.

Douglis points to a more artistic interdisciplinary collaboration in which architects and engineers, as well as other performance specialists, design and use a performance space. This interdisciplinary effort (called PIP class - Production, Performance, Installation) is designed for physical performance, further enhancing the interdisciplinary experience. David Gersten remarks that this type of interdisciplinary learning has also been key in creating his own projects (Arts Letters and Numbers Workshop). He states, *"I have filmmakers, and photographers, and astronomers, and neurologists, and philosophers, and anthropologists, I bring them all into everything I'm doing. They all come."* For a new project, *"we're going to have ten different disciplines coming and participating."* In his view, the most important thing is for these individuals to bring their disciplines together and use them to enrich the experiences of each other, rather than to meld their knowledge together.

Regardless of the generally positive views of interdisciplinary learning, not all participants regarded it in the same fashion. Jason Griffiths refers to the learning process as *"horrendously modularized,"* noting that the use of interdisciplinary learning is a means of overcoming this limitation. Jason Johnson argues that trying to cram multidisciplinary learning into a three-month period of a course is both difficult and not likely to lead to intensive learning. Finally, Ronnie Parsons argues that some questions do not make sense in the context of interdisciplinary learning, meaning that at least some learning needs to be focused within the discipline. Overall, however, interdisciplinary learning is valued by the participants for its importance and the new information and perspectives that it brings.

The Physicality of Design

A cluster of responses about time, space, scale, visualization, hand-drawing and embodiment of skills, and the result of technology as mediation makes it clear that the *physicality* of design remains an important aspect of the epistemology and ontology of the curriculum. These are not distinct from technology, according to some. David Gersten argues that space and time are being altered, not just mediated, by technology, and he cautions that these changes must be addressed in order to accommodate the changes that technology would bring. These aspects of learning could be referred to as the kinetic aspects of architectural learning.

Time, Space, Scale, and Visualization

Time was one of the least discussed of these aspects. Griffiths refers to the permanence of the architectural object as the main aspect of the discipline (although he also self-deprecates this position by acknowledging criticisms that this is a *"historically antiquated position"*). William MacDonald also remarks on the importance of time, and in particular notes the impermanence of a structure's usefulness. Observing that most of the residential buildings in Park Avenue, New York, were once office buildings, he states that designing a tight fit between use and space is less important than leaving room for evolution to occur. Mostafavi argues that this relationship with time is also echoed in the design process, with the designer needing to exercise control over the feedback loops to eventually complete a design. A related concern is that learning itself takes time, suggesting that there is no way to reduce the time associated with the program itself and still contribute to the learning required.

The manipulation of space, according to Gersten, is one of the key aspects of design and one of the main goals: *"I'm also saying that to manifest the widest spectrum of what it is to be human into our spaces and to listen to those spaces as things that are completing us is really [a] kind of big project."* However, most spatial discussions revolved around the programs themselves. The physical space of the program is a core issue for Anzalone, with arrangement of the program around a small central location facilitating interaction. This is also an advantage for Faulders, who notes that the studio is a key space that all students in the program use. However, he also acknowledged that, to some extent, students are freed from space because they can contact each other online when they want to. This concern was echoed by that of space within the design itself, with students needing to develop a sense of how a design would be enacted in reality, according to Faulders.

Tehrani argues that the limitation on space, forcing students into proximity, actually helps with collaborative learning. Awareness of scale is one of the main losses that students experience due to technology, according to Faulders and Gerber. Faulders remarks:

> *It’s a fairly small rectangular screen, and they are rotating potentially very large projects that should be the size of the city block or whatever that are representationally being explored as something that's the size of your fist. When you put that right on your screen, yeah, and they're twirling this thing around with their mouse, and I'm coming up to talk to them, and they ask me, "Well what do you think of my project?" And all I can say is, "How would I know?" And this thing is this little model . . . spinning around this three-dimensional construct. It's scaleless because we can make it whatever scale we want. It's beautiful and maddening at the same time.*

Gerber notes that it is important to maintain the sense of space in order to ensure that students can understand it within the design. To overcome the problem of losing awareness of scale, some of Gersten’s teaching problems involve building full-scale models of designs. He says, *“Full scale's one of the most interesting scales.”*

Khan argues that the loss of scale is one of the downsides of systems thinking, wherein the system-scale becomes dominant. In contrast, he also acknowledges that sometimes the loss of scale is not devastating: *“So, sometimes I look at these things and realize that they are not properly integrated or properly scaled, but there are other kinds of interesting geometric investigations that are happening.”* Visualization is the process of understanding how something can be built (enacted in space), according to Anzalone.

Faulders supports this view, arguing that being able to step inside the design and understand how it would look in built reality is a key skill. However, visualization was not discussed in detail.

Hand-drawing and the embodiment of skills

One crucial aspect of discussion was the importance of hand-drawing and the embodiment of skills and traditional craft. Most participants feel that hand-drawing and computer drawing are different skills (although Greg Lynn did not see a significant difference between them). David Gersten described the importance of embodied skills:

> *You know if you've chiseled wood, you have a chisel, and you have a mallet, and we all know that you don't chisel wood with a hammer… . You have a chisel and you have a mallet—a mallet's large. Why is the mallet large? Some people say it's because it softens the blow, and all these kinds of things. What's really going on is that our embodied knowledge of that experience, right, what's happening is that there's a double impact. This has to hit there. But our mental attention can't be there, our mental attention has to be there… . So the instruments create a kind of embodied experience.*

Gersten's example clearly demonstrates the importance of embodiment and technique in understanding the physical nature of the building process, and the integration of cognition and embodied skill (hand and mind) as an important factor in understanding the problem of architecture. Gersten also argues that drawing is a unique form of mediation that cannot be duplicated using a computer screen.

William MacDonald believes that hand-drawing is part of the architectural thought process and, as such, is extremely important for understanding the role of technology, a view supported by Ronnie Parsons. Omar Khan points to an over-emphasis on the use of technology as one of the things that leads to a loss of drawing skills. He notes that this is a shortfall in some respects (although technology increases the speed of production) because it results in *"opening up more possibilities than necessary."* However, the ability to analyze a machine drawing is something he notes as a significant benefit. In some respects, the *"manufactured fear"* (according to MacDonald) of losing hand-drawing skills could be exaggerated due to anxiety about developing new forms of embodied skill, such as machine drawing. Parsons states this explicitly, noting that a skilled machine drawing can be as detailed and comprehensive as the best hand-drawing; thus, nothing has been lost. While clearly the loss of hand-drawing skills is a concern, it is not certain that this is occurring or what the outcomes of this loss would be.

Mediation

The participants view the role of technology in design physicality as a mediation that has altered time and space relationships between design and designer. David Gersten argues that technology is a form of mediation between designer and design—and could therefore alter the distance between the two. Omar Khan argues that with the mediation of technology, immediacy of the design message is lost: *"I don't read a script, but I can read a drawing; [with the mediation of technology], that immediacy is lost."* Mohsen Mostafavi argues that a distancing of the design from the designer resulted from the use of technology, understanding this as a distancing of space rather than time. All three agreed that the end result of the mediation process of technology is separation and distance between design and designer.

Design Intuition, Design Rigor, Critical Thinking and Design Practice

This group of related concepts revolves around design intuition, design rigor, and critical thinking and their effects on the design process. These are related to the cognitive aspects of architectural learning in the same way as the discussion of physical and embodied skills above could be said to be kinetic aspects of architectural learning.

Design intuition and design rigor

Although design intuition and design rigor could be expected to be opposed concepts, in fact they are not. Instead, participants feel that both are important for developing architectural skill. Thom Faulders credits both the *"logics and the leaps of faith"* with design skill. David Gerber emphasizes the importance of design rigor, especially in understanding what the tools are doing and how they are being used. He notes that the goal of teaching is that *"we don't want to teach people to accept status quo—we want to teach students to critically engage and question status quo including the technology they are using."*

Gerber also notes that "*finding their voice"* is an important goal of teaching students. David Gersten echoes that goal: *"I want to make sure that people know how to listen to the world."* Jason Griffiths integrates design intuition and rigor, arguing that *"a process of contemplation"* is behind the design process and its creation. Tehrani views design rigor, especially in regard to integration of materials and spaces as well as decoration, as the key distinguishing feature of architecture. Thus, both design rigor and design intuition are seen as important in developing architectural skill.

The role of technology in developing these aspects of design skill is also important. Technology is instrumental in developing design intuition, according to Gil Akos, since it enables students to design more quickly; however, this is also somewhat dangerous, and students need to maintain the rigor of their design despite the potential speed at which they could design. He notes that this is one effect of technology:

> *The one kind of potential loss in design process is commitment to a particular portion of design or a . . . loss of rigor about how a project progresses so that it's not . . . a loose thing, but that you actually can in the process commit to things for a particular reason and move forward from there.*

While design intuition and design rigor are seen as key, they are also seen as vulnerable to the encroachment of technology.

Critical thinking and design practice

Unlike design intuition and design rigor, the participants view critical thinking and design practice as contradictory in many senses. Some participants agree that critical thinking is an important aspect of design outside the design studio, but within the design studio it is likely to lead to second-guessing and loss of focus and experience. Thom Faulders argues, *"Maybe the school isn't the place to be that critical. I think whenever we go to school, we are product of the era, right?"* Omar Khan argues that critical thinking leads to second-guessing design and prevention of the effective use of the technological tools within the studio (although they have their place outside the studio). In some respects, Khan argues for the role of critical thinking as the inverse of design creativity, acting as an inhibitory factor rather than a promotional factor in the design.

There are also different views of critical thinking and what it entails. Anzalone views the important aspect of critical thinking as considering how a design could be built and how it would look, rather than just the technical aspects. Douglis focuses on criticality as a means of rejecting superficial design and learning to critique one's own design, but feels that the seminars and readings, rather than the studio, are the appropriate place to reflect on this design. Faulders notes that the rejection of simply making forms is a step toward criticality. Griffiths feels that critical thinking demands rejection of entrenched positions for or against a given technology or technique.

The exclusion of critical thought from the studio is not absolute. For example, Douglis argues that students should be able to *"engage in your pedagogy, at the same time be able to kind of assess where they are in relation to everyone else, but also outside that studio."* Gerber feels that there is not enough critical thought in the studio, with students instead falling back to commercial-style designs without consideration of the meaning of the designs. Johnson argues that critical thought is also not taught outside the studio, with a disconnection between teaching historical design modes and demonstrating to students why these matter. Bruce Lindsey argues, *"I think, if it's a tool, then it's a lot of tools, and we don't typically think of our tools critically. Or we don't think of them as having a kind of theoretical history and/or potential in a way that they could lead to a new kind of architect."* Strongly on one end of the spectrum, Parsons argues that critical thinking is highly important within the design studio in order to select the right tool as well as to move beyond the technical tool in use.

Arrangement and Provision of Learning

The arrangement and provision of learning offered by most programs is fairly similar. A majority use a combination of design studios and seminars, with some (though not all) offering seminars in critical theory and history. Design studios could include hand-drawing and other traditional craft, CAD (of various types), advanced technology tools, physical simulations (including fabrication, 3D printing, and hand building of models), and other design and experimental techniques.

What was agreed between participants is that critical theory and examination of design primarily take place outside the design studio, in seminars and reading and discussion groups. Furthermore, design software are not commonly taught in graduate classes. Instead, participants state that graduate students either come to the program knowing how to use the software already or learned them independently. Other methods of providing knowledge and learning include collaboration with professionals and professional design studios, group and collaborative projects, and formal and informal workshops. Workshops are often oriented to teaching software, which are then used in the courses without further exploration. Each of these types of learning and knowledge is discussed in detail in further sections, which examine specific issues related to each of these areas.

Social Aspects of Learning

A number of social aspects of learning have been identified by participants, including self-led learning and goal-setting, student-led teaching and learning, shared authorship and open source, and issues surrounding professionalization and professional pressures.

Architecture as Cultural Practice

One shared vision of architecture is that it is a cultural practice. Gil Akos, defining architecture as a *"method of cultural production,"* cites awareness of this role for architecture as a reason for increasing social awareness and responsibility by architects. Faulders suggests that architecture has an important aesthetic role and argues, *"I don't think we're just here to solve problems only, and if we look at music, literature, film, or anything else, we're reminded of that constantly."* On the other hand, technology is also regarded as shaping culture, as expressed in discussions with Gerber and MacDonald (who both point to the Industrial Revolution was one instance where technology shaped culture). Parsons explicitly states that technology and culture have a mutually constitutive relationship, each affecting the other in a feedback cycle. Thus, based on the responses of these participants, it is clear that culture, architecture, and technology are related.

Self-Led Learning and Goal-Setting

One characteristic of the architectural pedagogy mentioned by several participants is an expectation that students should set their own goals and (at least to some extent) lead their own learning processes. Anzalone notes that the freedom for students to choose their own interests becomes greater as programs go on, with students increasingly experimenting with technologies and practices. Griffiths supports this, noting that the structure of his program enables increasing freedom. Ronnie Parsons compares the process of selection of an individualized curriculum to a choose-your-own-adventure game, with students taking different paths through shared choices.

The purpose of this flexibility is to enable students to become unique. Rather than being prescriptive about the learning process, Anzalone notes, *"What we as educators have to do is say, 'Where do you want to get to—not how do you do it, but where do you want to get to?' And then we help them understand . . . 'Cause we may not even know how to get to that point."* Gersten emphasizes this: *"I don't tell any of my students ever, PhDs or first-year undergraduates, I don't tell any of them what they should do. What would I know about what you should do? You have your questions, but I'll help you try to figure out how to be precise and how to take risks, and that's it."* He sees the formation of self-led interests as a means of amplifying humanity and increasing the spectrum of interests available.

Student-Led Teaching and Learning

A supporting feature to self-led goal-setting is student-led teaching, which was mentioned especially in relation to technology. Anzalone notes that formal seminars and design studios are often led by student interests, and many other participants note bottom-up learning processes similar to this. In some cases, however, student-led teaching is also implemented formally or informally, with students engaging in peer teaching through workshops or study sessions. Anzalone notes that his program does not ever teach technological tools/software. Instead, students either learn these design programs on their own or through informal workshops and tutoring sessions held by other students. This leaves more time to focus on design concepts and ideas in the formal classroom environment. This is also the case for Greg Lynn (UCLA School of Architecture and Urban Design), who states that he assumes students learn software elsewhere (although he does not specifically address peer learning).

Faulders notes that students often modify and redesign tools/software for their peer groups in order to improve their applicability to the programs. He feels that the group environment of the studio is an atmosphere targeted to peer learning, offering a high level of support for this type of informal peer-led learning. Nader Tehrani actually sees a significant benefit for peer learning. He states, *"It's also less hierarchical. It's not your studio teacher that teaches you. We are there for certain purposes, but your TA, your classmate, and the kid from Maryland is also doing this other thing. So, how we learn from each other, how we learn from the Internet and other vehicles, is pretty significant."* Peer-led learning is a highly important aspect of the education process and is very relevant to technology learning and teaching. This is particularly true given the position of many students as digital natives (discussed below).

Shared Authorship and Open Source

One of the most compelling areas of discussion relates to shared authorship and open source tools and materials. There are two foundational assumptions on which these attitudes are based. These assumptions include: 1) it is not the tool used to create the design that is important, but the design itself; 2) the tool does not create the design—the designer does.

Ronnie Parsons, who notes that implementation of most scripts is syntactic rather than being a true innovation, makes the following observation:

> *Whoever wrote the script can claim the authorship of its translation into a particular syntax—that's it. So if you write a honeycomb script, they didn't write—they didn't invent—any algorithm for a honeycomb packing. They translated that algorithm into a particular syntax. So they can claim authorship over anything except for the translation, right? And that goes across the board for all of the algorithms unless you invented an algorithm.*

Of course, even an implementation of an algorithm can be clever and worthy of recognition, which is the position of most interviewees. Most of the interviewees feel that use of open source scripts or shared scripts is acceptable as long as the user credits the original source. Some participants also valued the scripts for what they are. Evan Douglis says:

> *The whole movement of open source is fascinating, because especially it's scripting when you spend [an] enormous amount of time. I mean, you*

> *could spend months—and I know this from experience—trying to work out of script for very specific effect, and I'm pleasantly astonished. And I hold great respect for this generation that feels very comfortable about sharing that information.*

Thom Faulders also supports this assertion. He notes that, although it is possible for students to hide or fail to attribute the source of their scripts, there is no reason for them to do so. In fact, he notes that students often must be encouraged to reuse scripts and other open source tools, rather than wasting time "reinventing the wheel." Faulders further explains his position toward open source, stating:

> *It's really incredibly helpful, in fact it's rather sophisticated. To learn what others have done, history, to learn the craft, tools, and to take a little bit of time to build a kind of a foundation, the payoff is much better. And so we can understand . . . shared tools as similarly as we would with when they're doing analyses of case study buildings.*

Faulders encapsulates the importance of shared knowledge in open source scripts, suggesting that it is a way of sharing knowledge and information. Thus, the participants regard the use of open source tools and shared authorship tools not just as being harmless, but instead as being a means of improving knowledge and understanding the tools used. The participants encourage this as a means of learning, both to improve the learning process and to increase the speed with which students can apply the tools (rather than struggling with scripting).

This does not mean that the use of scripts and other open source tools is easy. Sharing credit and acknowledging authorship of scripts and other tools is a significant ethical norm shared both by academics and the hackers who create the tools, according to David Gerber.[1] Jason Griffiths notes that this norm is sometimes broken, indicating that

[1] In this case, "hacker" is used in a traditional sense, meaning one who hacks or creates and modifies open source software tools, rather than a pejorative sense implying illegal or destructive activity.

“we see [it] in very clear examples of where somebody just simply copied something.” Thus, the value of the open source script or tool shared among students is in acknowledgement, change, and questioning, rather than simply using the software without critical thought. Omar Khan notes that this type of plagiarism is easily defeated since most such scripts can be found with Google’s search engine.

Overall, the attitudes toward open source software can be summarized as follows. Most of the participants who addressed the issue accept and even encourage open source. They note that tools should be credited (and sometimes are not), and when they are, open source offers opportunities to increase the speed of learning, see how other people have solved a problem, and apply a design solution rather than focusing on process. Therefore, open source tools and shared authorship of tools are commonly encouraged in curricula where technological tools, such as those for scripting, are used.

Professionalism and Profession-Academy Conflict

One of the most significant conflicts found in the interviews is between teaching design and architecture as an academic discipline versus teaching design and architecture as a means of preparing students for professional life. Most of the participants who addressed the issue agree that preparing students for professional life is an important part of their duties. Gerber states unequivocally, “*Yes, it’s a responsibility of the school to educate our students to be successful in their practices… . We have to do that as a faculty. An ethical question: Are we keeping pace with the needs of practice?”* Not all views regarding the demands of the profession were as positive. Gersten referred to information technologies and modeling programs as *"the quick money"* and *"branding,"* rather than something having a lasting influence.

Participants also viewed teaching technology as part of the professional training process. Akos states:

> *I'd say that, in terms of the students becoming practicing architects, that definitely is a concern, and certain things are expected of a graduate of a professional architectural degree at this point in time. A lot of them, like things that professionally are in vogue, like BIM [building information modeling], those things are something that the school tries to integrate into comprehensive studio and more seminars so that the students can be tooled up in that design technology so that they can successfully practice in the world.*

Douglis also emphasizes the demand for new technologies, noting that the main force behind teaching many of the technological innovations in use within the school is to ensure responsible professional preparation for students. This position is complicated, though, by the sense that students should not *just* be prepared for technical specialization in the professional world. Faulders states, *"I'm really invested in trying to get them to think very proactively about this instead of: 'Oh, I just need to learn the tools so that I can get out there and get a job.' It's like, 'Yes you do, but… . We're the drivers of where this can go.'"* Jason Johnson also supports the view that students should be exploring, but notes that this is particularly difficult in the academy. He states:

> *I would say [there's] a tension, at least in our school, between teaching students to use digital media and the kind of experimental [tools] . . . teaching students to use digital media to produce drawings for buildings in a very traditional way.*

Johnson's view reflects the conflict between continuing to teach approaches like hand-drawing and the gradual implementation of computer-based drawing as a substitute or complement to hand-drawing, seen in many cases. Not all students or programs intensively focus on this post-graduate preparation. Gerber states that, to some extent, the degree to which students are taught technology for professional specialization is self-led: *"I think it depends on the spectrum of graduates and what their interests are and the spectrum of professional practices, too."* Thus, it is not necessary that all students be prepared to use advanced technologies, like building information modeling (BIM), in their professional practice.

There is also resistance from the academy in terms of the demands of profession. Khan states that, although his program provides a good grounding in tools like CAD, it does not try to meet every demand of the profession since tools change so rapidly. Rather than teaching professional tools, the program focuses on interaction with professionals through formal and informal relationships. Ultimately, meeting the needs of the profession is vital because, as Gerber states:

> *The implications for the professional practice are clear: The market needs digitally savvy, digitally capable, digitally rigorous people. And without that, the professional practice of architecture will continue to erode in terms of its actual control over projects. We will be reduced to drawing pretty pictures as opposed to controlling the designing project.*

Gerber's statement is ambivalent given that design tools increasingly make it easy to simply draw pictures and have analysis performed automatically. Not all discussion about the relationship between profession and academy focused on simply teaching tools and technologies. In some cases, the topic was the mutual influence of profession and academy. The professional role in leading the academy has already been discussed. Yet, the academy is often seen as leading the profession, especially in developing new tools and technologies as well as guiding the philosophical and critical discussion of design. Anzalone notes that many of the technologies in use in the profession came out of the academy, where there is room to be flexible and to explore theoretical possibilities. Khan supports this position as does Faulders, who points to the exploration of real-world ramifications of design as one of the issues that can be more easily done in the academy.

Overall, the profession and the academy are symbiotic yet conflicted. Both the academy and the profession offer advantages, such as tools that are integrated into the curriculum. The academy offers opportunity for experimentation and reflection, which is integrated into practice through the transition of students into the profession. At the same time, the profession offers a challenge to the academy to integrate and adopt new technologies and ways of working.

The Role of Technology in Architectural Pedagogy

The participants provided a wide range of insights into the effect of technology on the architectural curriculum, as well as the more general issues discussed above. These specific roles are the focus of this section.

Digital Natives and the Generation Gap

Generational differences between students and instructors, and among instructors, is a significant factor in views of technology. As many of the participants noted, most students are already, or are moving toward, the generation known as *digital natives*—those who have never known a time without digital technology and who easily assimilate concepts, norms, and practices associated with technology. These participants often arrive already knowing how to use technology and how to teach themselves or informally teach each other. They are active in making and modifying technology tools to suit their needs. Similarly, many participants indicated that their schools no longer teach software specifically, but instead rely on the fact that students already know the various design programs in use or are able to self-teach.

In contrast, the adoption of advanced technologies by faculty is often a matter of conscious choice. For example, Greg Lynn reports that he *"went digital,"* or began using technological tools, in 1996. Although still young at the time, this meant that he was already a practicing professional when he began integrating technology. All participants asked about generational differences indicated that this likely played a role in resistance to technology from older faculty. Evan Douglis says about this resistance, *"I know this sounds funny, but there are firms—like even Richard Meier [the convener of the MIT virtual studio, discussed below] was very uncomfortable leaving ink on Mylar drawings to get onto AutoCAD."* Older faculty in particular may have considerable difficulty with adoption of technologies due to resistance to changing social norms and the potential that technology could make architects *"mere technicians."*

Technical Specialization and Making Technicians

One frequent concern that the participants addressed, and one that is also related to the influence of professional demands on the academy, is the effect of excessive technical specialization in the architectural training process. A general statement of this fear, as distilled from several participants, is that architectural training is in danger of excessive specialization on a specific technological tool or paradigm (such as BIM, frequently mentioned in this role). Pressures to specialize come from professional practice. As a result, the architect becomes a technician who draws pictures of designs to be implemented by someone else, or who uses automatic design techniques and modular designs to eliminate involvement in the design process. This also runs the risk of creating cookie cutter designs, which reduce the interest and uniqueness of architectural objects. Ultimately, as Greg Lynn expresses:

> *[Architectural training] can become vocational training rather than design when it is seen as a science rather than a medium. It also makes designers into amateurs, and studios are often using the crutch of experimental digital design to mask that they are not expert in their use of the technology.*

Not all participants agree that this would happen. In particular, the human judgment associated with design suggests that there might not be such a negative effect. (This is discussed above, regarding physicality and understanding the nature of the problem.) Nevertheless, this is a significant enough concern that it should be considered to be highly relevant to the role of technology in architectural pedagogy.

A related concern to tool specialization is the issue of tools/software becoming outdated. A number of participants note that teaching specific tools is inappropriate because tools are routinely upgraded and replaced. Despite the relatively short history of CAD, for example, a large number of tools have already become obsolete. Thus, participants feel that the emphasis on learning needs to be on *skills*, not on *tools*, in order to prevent skill obsolescence (and also the problem of architects becoming mere technicians). David Gerber suggests that greater involvement in tool creation is a potential way to avoid this problem: *"In many ways architects are becoming tool makers as well as project designers, and students need to understand what that really means and when they need to be a tool maker or just a tool user."*

<u>Changing Social Norms</u>

A third major critique of technology in architectural pedagogy is the change of social norms associated with technology. Participants view the learning of design and technology as highly collaborative, particularly in the design studio, and many of them engage in cooperative projects and designs. The use of student-led teaching also increases the emphasis on collaboration. The proximity in the classroom is also a major factor in promoting team learning and collaboration. There are, however, changing social norms and negative social effects attributed to technology that result in reduced effectiveness. Evan Douglis imagines a virtual classroom connected by Skype or other technologies; while this expands the scope of the school, he notes that it is problematic in nonspecific ways. Thom Faulders notes that this arrangement has its limits, in particular in how much participants can be said to be working *together* in a physical sense. Jason Griffiths is perhaps the most pessimistic in describing the changing social norms associated with technology:

> *It de-socializes design in its worst form. Or it de-socializes communication… . I think what the computer allows one to do in a completely immersive environment is to not only separate yourself from what is the design, the social structure that is design… . And the other issue as well is, I think, the alienation of the individual student.*

It is clear that technology does affect architectural pedagogy. However, these examples have shown that the extent and nature of technology's impact on social norms in the classroom is complicated and contested. Skype and other collaborative technologies extend the reach of the classroom, but this is at the expense of depth of communicative relationships identified by Griffiths and Faulders.

Benefits of Technology

This discussion of technology has been extensive and has touched on a number of key aspects of the uses of technology in architectural pedagogy. The simplest question remains: What is the benefit of using technology in architectural pedagogy? The participants had myriad answers for this. There are four clear benefits stemming from the use of technology in the architecture classroom. In particular, technology provides an instrumentality (or means) to various ends, such as improving speed and output capacity, enabling innovation, allowing experimentation, and extending the ability of the student to calculate complex designs.

Technology as Instrumentality

The basis of most of the benefits for technology is that it serves as an instrumentality, or means to achieve an end. Gil Akos characterizes the role of technology as removing barriers to achieve specific designs or solutions, as well as enhancing the clarity of presentation. This instrumentality is not complete, as Thom

Faulders notes, since *"[architecture] is not an engineered way of finding solutions."* Thus, technology cannot be the only instrument used to achieve architectural ends. This can also lead to problems with, as Mohsen Mostafavi puts it, *"valorization of technology"* through excessive emphasis on the technological process rather than the solution to which it leads.

Technology not only acts as an instrumentality, but it must be a means rather than an end in itself in order to be effective. Ronnie Parsons emphasizes that the instrumentality of technology is not absolute, either: *"That makes some assumption that the computing environment might not offer a new way of thinking about things that you'll discover with your hand at a later point in time."* Thus, technology is *an* instrumentality of architectural design, but it is not *the* instrumentality of architectural design. Regardless, it is this role as instrumentality that leads to many of the benefits of technology.

<u>Innovation and Efficiency Gains</u>

The most apparent benefits of technology mentioned by participants include innovation and efficiency gains. Phillip Anzalone notes that the simple act of not needing to redraw designs in order to incorporate changes is a simple efficiency gain, one that was mentioned as being revolutionary by a number of participants. However, as Anzalone also notes, there are design efficiencies that can be gained through the use of technology:

> *There's also the ability to do analysis that allows you to say, "Well this is a more efficient building because of this. Or I'm using less material because of this," incorporating it with other things like digital fabrication,*

> *like computational analysis, to help design efficient buildings [such as] solar analysis and things like that. So the tools themselves are able to help change how you do design instead of just being a faster pencil.*

This is a form of efficiency that Evan Douglis re-emphasizes. He notes that the ability to analyze the design and consider aspects, such as energy efficiency, improves both the quality of the design and the ability to meet contemporary standards for architectural design. Jason Griffiths notes that this integration of systems and design is a newer demand that must be taken into account, adding that this form of efficiency is particularly important for recent designs. Thus, improving the efficiency of designs—both the speed at which the design can be constructed and the ability to analyze the design for efficiency—is a major benefit of technology.

Similarly, many participants indicated that the ability to implement innovations is a major benefit of the use of advanced technology in the architectural pedagogy. As with efficiency, participants define the idea of innovation variously. Faulders sees the use of technology as an innovation in and of itself, noting that there is no need to continue to use existing techniques. He also notes that technology is particularly good at stimulating innovation from the bottom up, especially for students who are digital natives and are therefore comfortable with technology.

This emphasis on technological innovation is not necessarily positive. Lynn associates the growth of demand for technological innovation with the decline of cultural discourse, thus reducing the cultural relevancy of architectural design. Douglis suggests that technology could be used to support non-innovative practices: *"I suppose I am speaking as an educator here because, if you don't have that ability to think independently, then you are going to have to be acquiring architectural imaging and* *scripts through the rest of your life because you can't—you don't—have your own voice."* He notes, however, for those who do have a design ethic and independent thought, these scripts and imaging programs as well as other technologies may serve to support innovation in both process and outcome. Although technology is clearly seen as a positive feature for many of the participants, who view it as a way to reduce the amount of re-work and improve the efficiency of designs, the question must be raised as to whether hand calculations, hand-drawing, and other "inefficient" methods do serve a pedagogical purpose that serves to imbue the design ethic and independent thought Douglis identifies as critical.

Experimentation and Speed

Another way that interviewees suggest that technology has benefited the architectural pedagogy is through enabling experimentation. A general statement of this view is that experimentation under non-computerized methods is difficult. Using ink and Mylar or pen and paper drawings, it would have been possible for students to complete only a few drawings per semester, limiting the extent of experimentation they could undertake because of the limited amount of time they have. Now, the much more rapid CAD-based drawing systems enable students to complete many more designs. More importantly, however, scripting systems like Grasshopper, Python, and Firefly enable students to see other designs and play with them, changing parameters and observing the effects on their design. Anzalone notes that this experimentation can go even further than the simple physical characteristics of the design.

While it is not possible (or at least not easy) to analyze the energy efficiency or other physical characteristics of a hand-drawn design, computational analysis programs enable this in a user-friendly way. Students can experiment not just with the aesthetic aspects of the design, but also with the functional aspects. Griffiths observes that this type of experimentation has a vital role in the learning process (though not one that students take advantage often enough):

> *Then you have this really, this great opportunity to criticize something, or you create something . . . or you make combinations of things that say to themselves, and then you accept or reject—quite often just reject whatever you come up with putting disparate things together. So if I said I want to make . . . a garden shed, but make it all out of diamonds—and there are whole sort of reasons why one wouldn't want to do that—but in doing it . . . you can quite often discover things that you wouldn't discover unless you were attempting to connect disparate things. So for me that's where it lies, really, and I think students do that rarely. And it does happen on occasion, but it's very rare.*

Technology increases the number of drawings that students can do and, by expanding the ability of the student to experiment with disjuncture and other elements, offers students the opportunity to learn things they could not do otherwise. This is a view Mohsen Mostafavi shares; he notes that many designs emerge through technology that would not be possible without it.

As already alluded to, the speed of production using technological instrumentalities is a prerequisite for realizing the experimental benefits of technology. However, this is in itself a benefit mentioned by participants. The use of technology as a key design tool enables students to complete more designs and find better designs through experimentation, producing more designs over the same period of time. While technology may reduce the speed of design and output quantity for students, there are still tradeoffs that need to be considered. Some of these tradeoffs include the cost of technology, the tendency of software to drive the design process, and the potential loss of embodied learning that could result from over-reliance on a particular technological tool.

Future Visions

Relatively few of the participants offered insights about the future direction of architectural pedagogy and practice. The most common insight is that there will be an explosion of tools and paradigms intended for practice. A less common, but highly detailed, set of insights revolves around the evolution of virtuality and even, in the view of some, the emergence of transhumanism, or a state of merging man and machine to become one thing. Of these, the first is clearly more relevant for practice, but the second is more intriguing because it challenges the very notion of what it means to be an architect. A few believe that there will not be significant change; Mohsen Mostafavi feels that the main change will be further integration of technologies and tools until these technologies are accepted to the point of being unremarkable.

Explosion of Tools and Paradigms

The most common concerns expressed for future development of architectural technology relate to an explosion of tools and paradigms. Gil Akos suggests that there would be more tools, many adopted from outside architecture and many with improved communication capabilities.

Jason Johnson indicates that customization, both in software technologies and manufacturing technologies (like 3D technology), will be more in demand. This, he suggests, would lead to greater involvement and more assertiveness on the part of architects in designing and creating their own tools. He also envisions actual modulation and control of buildings and spaces through sensors and other electronic tools as becoming more important for integrating space and function. Omar Khan, who sees performance-based design facilitated by tools, echoes this. He feels that this might be accompanied by a shift away from emphasis on specific *products* and more toward specific functionality and processes, which could be implemented with any paradigm.

William MacDonald emphasizes the importance of the environmental paradigm, suggesting that future buildings and even neighborhoods could routinely be built off-grid. This, according to Mostafavi, will require more efficient use of resources and more innovative approaches to design that do not simply rely on limiting use of materials. Tehrani views this improved efficiency as particularly important for designing architecture in developing countries, which he thinks will become increasingly important to the profession.

Virtuality and Transhumanism

Participants regarded two concepts as becoming more prevalent in future than they are now: virtuality and, by further extension, transhumanism. Darren Petrucci (Arizona State University School of Design) imagines virtual design seminars and studios of the type pioneered by Richard Meier at MIT as becoming inevitably more common, a position that many participants, like Bruce Lindsey and Evan Douglis, support.

Others, like Jason Johnson and Greg Lynn, describe virtuality as something that is already happening in workshops and seminars, particularly where students adapt their own modes of interaction. Douglis notes that design studios, including his own, may already be using avatars to engage with each other. Thus, virtuality and virtual representations of designs and people are two changes that are already underway.

Transhumanism is a more esoteric concept, addressed directly by Evan Douglis:

> *Innocent-machines and the human species—but the two in a kind of transhumanist view—are potentially intermingled, and part of that will happen at the nanotechnology level. Part of that probably will happen in terms of the flesh of architecture, whether it's an exterior skin or an internal skin being able to transform in real-time. And there will be a closer alignment between the body, as a body of desire, and then the architecture as an extension of that desire in terms of transform[ation] and changing.*

Transhumanism is a minority view and would require a substantial revision of practices of embodiment, as well as a reconsideration of what it means to be human. Nonetheless, this is a far-future vision that should be considered seriously as a potential point of further evolution for technology in architecture.

Summary

This research produced numerous findings, which are summarized as follows. First, the curriculum and pedagogy does not have explicit links to the past apparent in its epistemology or practice. In fact, participants seem keen to reject the past, finding it either inadequate or just irrelevant to the concerns of the contemporary curriculum. Regardless, no single paradigm has emerged that can be identified as the leading paradigm or current approach. Instead, architecture schools have almost entirely taken a heterogeneous approach to curriculum paradigms, knowledge, and technology within their walls. Within a shared framework of seminars, theory courses, and design studios, and with the support of multidisciplinary efforts, curricula have taken shape that support the use of advanced technology in multiple and varied ways. Determinants of teaching practice are not formulaic or institutional, but at least on first glance appear to be predicated on the individual preferences of students and teachers.

Pressures in the architectural pedagogy, such as generational differences, pressure from professional practice, and ideologies of design, all influence the integration of technology into the architectural classroom. The degree to which technology is actually integrated into the curriculum is debatable. Fears like changing social norms and even alienation of students from each other, the loss of embodied skills such as hand-drawing, and the obsolescence of the profession are concerns that the interviewees articulated. Even those who have the strongest acceptance and even valorization of technology concede that technology poses a danger as much as it does a benefit to the profession of architecture.

Despite this cautious approach to technology, participants also see significant benefits to its use. Technology speeds up work, improves efficiency and accuracy, and allows students to focus directly on the problem at hand. Technologies enable students to *analyze* a design and not simply draw it, empowering them to consider the effects of the design on the world. Collaborative learning and open source tools also enable benefits, such as allowing students to see other ways of solving a problem. None of these tools enables students to escape the core of understanding what the nature of the problem is and how it should best be solved; instead, they only offer different ways of resolving a problem.

Perhaps most importantly in this chapter is the finding that technology is becoming somewhat integrated in the architectural classroom, although there are still a number of gaps and inconsistencies in this integration. Rather than being a skill that is taught explicitly, many programs now assume that students come to them either already knowing how to use software tools or easily able to learn them. Teaching of a design software may be relegated to student-led workshops, or even ignored altogether, with students self-teaching and selecting their own computer programs or other approaches for use in a particular problem. Thus, there is a movement away from teaching the use of the architecture or design software themselves like AutoCAD, although this is met with a tension from the profession, which demands the teaching of certain approaches such as BIM. Instead, students learn design skills, and select technologies or non-technological approaches based on their own preferences.

There is still room for improvement as participants report a lack of critical thought and inappropriate application of tools and technologies at times. The results of this suggest that over time, particularly as the so-called digital native generation takes hold, technological tools that are currently contested by some within the architectural program may become unremarked and unremarkable. The next chapter discusses this potential, and the dissertation concludes with thoughts on the outcome of the study.

CHAPTER 5: DISCUSSION AND CONCLUSION

The previous chapters have built a logical structure to support understanding the outcomes of the study. Chapter 1 introduced the study and posed the key research questions. Chapter 2 presented a general literature review to explore the pedagogical concerns of technology and the architectural classroom and to examine historical modes of architectural pedagogy, particularly in the Bauhaus and Vkhutemas schools. Chapter 3 detailed a structured qualitative methodology, a combination of phenomenological and theoretical approaches. Chapter 4 presented the findings of the study using a thematic and narrative approach to describe the phenomena that were observed in the research environment. These findings were based on individual interviews with 18 professional architectural educators around the country. Chapter 5 concludes with a discussion of the theory that can be derived from the research regarding the role of technology in today's architectural pedagogy. The findings of the research are then contextualized with discussion in terms of existing studies. Finally, the study ends with a critical evaluation, including discussion of methodological issues, limitations of the findings, and areas for further research. This will lead up to a final conclusion on the dissertation.

What Theory Can Be Derived?

The goal of the grounded theory analysis was to derive, from the phenomenological statements and experiences of the participants and their integration, a theory that could be tested using observation and other analytical techniques. This has proved to be difficult because of the range of responses and depth of information derived from these responses. Despite the inherent complexity of this undertaking, analysis of the findings and the relative strength of these findings suggest that there are two possible theories that can be drawn from them.

The first theory derived from this research is that *technology acts as an instrumentality in the design studio*. That is, computational technologies—including CAD and CAM—are not undertaken in the design studio as an end in and of themselves. Instead, technologies serve as a means to achieve a design goal, such as simulation, modeling, or other creative techniques. This theory explains why most architecture programs do not teach an introduction to design software, or only teach software programs informally at the graduate level, because they are only serving as one of the aspects of design that students use to implement their architectural models.

The second theory derived from this research is that *advanced technology is only one of the aspects of the total human experience that architecture students must use*. This theory is derived from Erich Jantsch's notion of the total human experience, and it is supported by many aspects of learning within the design studio and seminar that the participants mentioned and even explained in detail. Of course, technical knowledge—such as the understanding of networks, social sciences, the arts, and the physical sciences—was included as background that participants regarded as essential. In addition, participants believed other forms of knowledge and experience to be relevant, one of the most important being the *embodiment of skills*. This embodiment integrated awareness of space, time, and scale as well as the functionality of buildings and devices. Hand-drawing is one embodied skill mentioned by many participants, and building to scale, simulation, and modeling are other techniques used to formulate the embodied awareness of space and time required to create a successful design.

There were other significant aspects of the human experience lurking beneath these discussions. Of particular interest was the PIP project (Production, Performance, Installation), in which students engage with other disciplines in order to create a space for and then interact in performance. Another underlying aspect is the focus on design rigor and design intuition, where the humanity of experience is seen as the key element in the architectural design process. This study makes clear exactly how much of architectural knowledge and skill does not involve understanding the technologies behind the process of design; instead, understanding the process of design itself is fundamental. Thus, technology is an important tool in the design studio, but it does not compensate for the other human experience tools that must be used in order to appropriately execute the design role of the architect.

How Does This Fit With the Literature?

Both phenomenological and grounded theory methodologies call for development of the initial research without reference to the existing literature in order to avoid prejudicing the description or theory construction. But, comparison of the findings to existing literature after the fact is an appropriate area of discussion for the post-hoc analysis of the research. This section compares the findings and theories to the existing literature (in Chapter 2), noting areas of particular resonance and dissonance with the information derived within the study.

Computational Technology as Technical Paradigm

One particularly resonant point within the literature is Giovanni Dosi's definition of scientific and technical paradigms, he defines *scientific paradigms* as an outlook toward some type of technology, while *technical paradigms* are the models or pattern in which a solution or outcome will be achieved from the outlook or scientific paradigm that exists.[1] This work draws a distinction between the definition of a *problem* (the scientific paradigm) and the definition of a *solution* or potential solution (the technical paradigm). Within this research, it becomes clear that most of the emphasis on computational technologies, such as 3D printing, modeling and analysis, or even digital drawing, is based on the understanding of computational technologies as a technical paradigm. This position of technology is at the core of many of the observations of participants, who noted that understanding a given technology and its uses does not solve the problem of architecture (the scientific paradigm defined within the design studio). Instead, the technology is merely an instrumentality or technical paradigm that is used to define a potential set of solutions for a given problem. This explains the frustration of the participants with students who inappropriately define the technical solution as the problem. One example is the student who creates an aesthetically pleasant "fly-through" that does not do anything, what Greg Lynn referred to as an "obsession with forms." Thus, this is a particularly important observation for these findings, and it is inherent in the theories derived from the research.

[1] Giovanni Dosi, "Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants and Directions of Technical Change," *Research Policy* 11 (1982): 152.

However, Dosi's further observations regarding the economic nature of technological paradigm selection are equally important. In particular, there is the problem of how technological solutions are preferred or selected. Many of the participants indicated that specific technological solutions are not specified within the design studio, but these solutions (such as BIM or Rhinoceros 3D) emerge nonetheless. Thus, it is worth considering which economic factors (such as professional practice pressures or the open source movement) lead to the adoption of particular paradigms and whether other solutions that could be superior are being ignored because of lack of impetus to adopt them due to external market pressures.

Modernization and Systems Theory

Of particular interest in these findings is the explicit rejection of the foundations of modern architecture by many of the participants. In some cases, participants simply did not say much about the historical influences of architectural pedagogy. In a few cases, though, participants explicitly rejected or devalued this bias. They felt that it did not apply to the contemporary curriculum. Yet, it is clear that historical precedent has not been completely rejected; for example, the Pratt Institute, with a first-year foundation course followed by increasing specialization, still has a curriculum that bears a certain resemblance to that of the Bauhaus and Institute of Design.

Participants also strongly rejected systems theory. They felt that it was no longer relevant, or perhaps had never been relevant. This is particularly important given the foundation of systems theory, which "argues that the concepts and principles of organization in natural systems are independent of the domain of any one particular system."[2] This study does not see modularization or algotecture (previously supported as a major paradigm for contemporary design)[3] as the main impetus for integration of technology into the classroom. Instead, the *particularity* of a given design has become dominant, rejecting the idea that architectural units should be similar or modular. This idea rejects the notion of reusable, modular, and component-based design, which has been dominant in architecture in recent years. In this view, information and design technologies enable individualization and particularization, rather than modularization. This suggests that there is some resistance to the notion that technological implementations of architectural tools should be more than "computerized pens," but instead should be algorithmic implementations. This is worth considering because it represents a view that is perhaps in the minority of the current practice of architecture. Yet, this is not an area that was fully explored within the interviews. It might be worthy of future study.

It is particularly important to note that the findings vis-à-vis the position of the designer are similar in algotecture and the current research. In both cases, the designer, rather than the software program, must make choices that lead to the final design, and the program can only alter the parameters of the design visually and technically (or, in some cases, provide differential analysis as to what the design implementation would be like). This is particularly relevant to the selection of aesthetic values, which cannot be

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[2] Hensel, Menges, and Weinstock, *Emergence*, 15.
[3] Terzidis, *Algorithmic Architecture*, 37. Modularization refers to the composition of modular units that can be combined for a single design, while algotecture refers to the use of algorithms for architectural design.

adequately chosen using a rules-based technological system.[4] This is a shared position on the role of the designer, but not all participants were as supportive of novel technologies as were writers like Terzidis. It is important to note, however, that even when designers remained in control of choices, they still used technology to provide them with a menu of choices they could not access otherwise.

Few (if any) of the participants specifically referred to *taste*, which Dorfles considers to be "idiosyncratic and irrational"[5]; yet, this is a part of the individual and human contribution to the design process. This is particularly relevant given Jantsch's discussion of the role of total human experience.[6] Jantsch holds that the architect must take into account the totality of rational, sensory, and emotional experience in order to arrive at design values. In other words, it is informed by sense, experience, and social position. As such, this type of experience must be considered in light of the intent of the design. This suggests that students must not only be taught to use their own experience, as Jantsch suggests, but also must be taught to ignore parts of their experience that do not fit with the intent of the design.

"Digital" Architecture or Architecture Using Digital Tools?

Some of the literature evolved from the development of a stream of thought concerning *digital architecture*, which is based on the observation and design of complex

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[4] Ibid., 38.
[5] Dorfles, "The Proairetic Factor," 83.
[6] Jantsch, "Education for Design," 114–115.

systems.[7] Of particular importance within this paradigm is the use of composite materials, which offer specific material and structural characteristics for design and which can be manipulated according to parametric rules.[8] Participants in this study did not support this position as a means of designing or experimenting with design within the design studio. This is accurate, even though modeling and building designs does remain a significant part of the project. Although fabrication studios were important, most of these focused on wood, metal, or other traditional materials (and a few of the fabrication specialists mentioned 3D printing). Thus, the use of digital architecture in the sense discussed by Kolarevic and Klinger is not necessarily ascendant, or even very present, in the design studio. What is clearly present, though, is the employment of digital technologies for design, such as CAD. This is one of the distinguishing characteristics of the digital native.[9]

In *The Future That Is Now*, Stan Allen considers the introduction of CAD as the key difference between current architectural pedagogy and previous pedagogical models.[10] This position has some merit despite the explicit rejection of earlier pedagogies by researchers, particularly given the transference of techniques (such as hand-drawing to machine drawing, or the continuation of model building) from earlier studio-based design models. Thus, it seems likely that there are two situations that are not quite as expected. First, the incorporation of technology in the design studio does not represent so much digital architecture as defined by Kolarevic and Klinger as it does the use of digital modalities for enacting traditional design. Second, this use of digital modalities does not

[7] Johnson, *Emergence,* 21.
[8] Kolarevic and Klinger, *Manufacuturing Material Effects,* 6.
[9] Allan, “The Future That is Now,” 216.
[10] Ibid., 204.

negate the previous pedagogies so much as it extends these pedagogies to make use of new tools. Thus, in several ways the current pedagogy is not as transformative or as transformed as either the critical theorists reviewed in the literature or the participants in the primary research imagine it to be.

Interaction with the Physical World

Perhaps the most important point uncovered by this research is that engagement with digital technologies has *not negated* the importance of interaction with the physical world. It is possible to engage in virtual studios and virtual design, but the product of the design effort must still be built for humans who are the same size and shape and using their spaces for largely the same purposes as they have throughout history. Buildings still decay and are repurposed. Despite the control of buildings by iPads or other technological innovations, students must construct and develop a sense of time, space, and scale that informs their choice of design, and they must be able to visualize the outcomes of the design process. To do otherwise is to reject the basis of design as a physicality and embodiment of the cognitive understanding of the world and to reduce the practice of architecture to simply, as one participant put it, "making pretty pictures." Participants regard hand-drawing, the craft of the Bauhaus and earlier periods of modern architecture, as the key aspect of creative effort. It demonstrates the embodiment of architectural skill by many (although a few participants acknowledged that a skilled digital drawing was equivalent).

The discussion of time, space, and scale is extensive in the literature review and will not be repeated in detail here. The issue of hand-drawing, however, is particularly relevant because it has such a history in architectural pedagogy. Traditional Bauhaus pedagogy focused on hand-drawing even before there was an architecture program; for example, artists such as Klee devised drawing exercises that all students learned.[11] These exercises resulted not just in the development of a particular skill by students, but also in a particular appearance to their work that made it possible for others to recognize an individual's style. Thus, drawing for the Bauhaus student was not just a means of showing the embodiment of a general skill in representation, but also a means of marking oneself as the student of a particular master.

Baudrillard considers drawing to be one of the three modalities of design,[12] suggesting that representation is once again key to the development of design. Design has also become, in the postmodern era, a *political* rather than simply utilitarian or aesthetic issue.[13] Thus, whether drawing is a required skill or not remains a political question rather than an aesthetic issue. This political nature of hand-drawing, the history of drawing as marking oneself as a member of a particular group, and its rejection as simply an aesthetic skill raises the question: Is the objection to machine drawing truly an argument based in the loss of embodied skill, or does it represent an argument about the loss of embodied social belonging? This could be a reaction to changing social norms, not the loss of embodied skill that marked the architect as a distinct social category.

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[11] Wingler, *Bauhaus*, 5.
[12] Baudrillard, "Design and Environment," 54.
[13] Ibid., 64.

Critical Analysis

There are three points of critical analysis selected for final closure of the research. These include a brief methodological critique, a discussion of the limitation of the findings, and opportunities for future research. The researcher feels that these aspects of critique best reflect the purpose of the research as well as communicate its major strengths and weaknesses.

Methodological Critique

Although the methodology used within the research was well-designed, it could have been improved. Three points of discussion include what went well, what could have been better, and what would be changed if the research were to be undertaken again.

The best part of this research was the openness and willingness of the research participants to converse and provide information and opinions in the research area. Several participants spent over two hours talking in person or via Skype, despite their clearly busy personal and professional lives. The depth of information and thought contributed by the participants was exceptional and offered more information in numerous areas than one researcher could handle alone. Thus, the best part of the research was clearly the support and work that the participants offered.

In terms of what could have gone better, the main issue was in focusing the interviews and keeping them on track. A semi-structured interview approach was selected to enable participants to explore areas unguided by the researcher's own preconceptions, and this *was* effective. But, in some cases, the interviews diverged too greatly from the topics of research, while in tangential areas participants provided a torrent of information. At the conclusion of the research, a significant amount of information had been gathered that did not fit into the structure of the research questions. Much of this information provided avenues for potential exploration, but was peculiar to the interests of a single person or a small group of people and therefore did not offer enough information for analysis. Providing stronger focus to the interviews would have been a significant improvement.

If the research were to be performed again, or if similar research were undertaken, the key design change would be to conduct multiple interviews, perhaps of shorter duration, for as many participants as time would allow. This is the approach recommended by Seidman (2006) and others, as it enables identification of key issues in between interviews. In this case, it would have allowed deeper exploration of central issues following the first round of interviews, and it also would have offered a second chance to refocus and reformulate the areas of inquiry. Thus, the use of two or three interviews per participant, rather than the single interview structure used in this research, would be more beneficial.

Limitations of the Findings

Disregarding the methodological challenges noted above, there are some limitations to these findings that should be considered. The most obvious limitation is that the findings are time-bound and space-bound. The interviewees were all from the

United States, and as noted in the literature review, the U.S. has often had a different approach to architectural pedagogy than that of other countries. Currently, it also has a different economic and political environment, which could change the influence of various architectural pedagogies.

Time is also particularly important in this research. The research has taken place at a time when there is a distinct generational divide between older and younger architecture instructors, as well as between instructors and most students. The attitudes toward technology are in flux, but these conditions will not continue forever. Simply stated, while instructors often see technology as an external introduction, and even a rare resource, many students (especially younger ones) increasingly regard technology as a plentiful resource to be taken for granted. Technology is as much a part of the current academic environment as pens and paper (if not more so). As these students become instructors themselves, it is likely that the role of technology will become increasingly common and integrated into assumptions about appropriate working practices. Changes that are currently ongoing, such as the introduction of Grasshopper, Python, and Firefly scripts within Rhinoceros 3D CAD application, will become integrated and will gradually fade from significance. Thus, the current situation in architectural pedagogy will not be expected to continue forever.

The third limitation is associated with the qualitative nature of the research. There were over 30 hours of interviews recorded for the research, including interviews with people who were astonishingly erudite and had clearly thought extensively about this topic. Not all of this information could be included in the findings of the study, and there are many potentially important points that had to be excluded since they were more marginal to the main thrust of the research. In this sense, a common critique of qualitative research is somewhat justified. The findings had to be selectively edited in order to focus on specific areas. While the researcher does not believe that the findings unduly reflect his own prejudices and pre-existing ideas about the topic of research, his personal judgment is a part of the findings. This is a key element of the interpretive paradigm under which the research was undertaken, but it is still an issue that should be considered when assessing the impact of this research.

Opportunities for Future Research

In some respects, this research opened up more questions than it resolved regarding the nature of technology in the architectural classroom and the architectural pedagogical theory. A means of resolving these questions could be to undertake observational research and work with students in the design studio and seminar. This research could involve ethnography, observing and participating in the design studio, and asking students and teachers about the type of technologies they are using and the ways in which they are using such tools. This could provide concrete and specific information about the technologies in use and how they are contextualized in the classroom

This proposed study is strongly recommended as a follow-up to the current research, particularly since it would also offer the opportunity to compare practices in the academic studio versus the professional office, and to question which is driving which. This could enable the researcher of a given project to determine whether there are unspoken paradigms of technological integration that need to be taken into account. This type of research would be useful to determine where students were learning technologies and ensure access to vital technological knowledge was being offered. Otherwise, there is the possibility of accidentally creating a new digital divide.

Conclusion

After all of this, what can be said about the contemporary integration of technology into the epistemology and curriculum of the contemporary American architecture school? It is clear that technology is not, for most schools, an area of focus for theoretical or tool development. This is not to say that tool development is not occurring, or that these developments are not exciting, interesting, or potentially fruitful. What it does mean is that technology has remained an *instrumentality*—a means to an end, rather than an end in itself.

Technology—whether quotidian technologies such as parametric modeling, simulation software, or other advanced fabrication techniques—remains one of the tools that architects and architecture students use to realize their designs, along with older tools such as hand-drawing, modeling, and simulation. Computer technology has not taken the place of the human imagination or design intuition or rigor, and it is not expected to do so. In fact, much of the work of architecture schools as described within this dissertation does not revolve around using technologies, but in understanding what the problem is that a given design is supposed to solve.

Participants identified this discernment of the problem and identification of potential solutions as the key aspect of design and simulation technologies that are useful. Situations where students fail to do this (the student who presents a design that is *cool* without being useful, or the student who presents a design with no understanding of the scale or implementation possibilities) remain a perpetual frustration to the participants in the study.

Similarly, participants viewed the professional emphasis on teaching specific tools as cause for concern and even fear. They saw it as a path to loss of the value added to the practice by the design professional. One participant expressed a concern that the excess reliance on technology could, in the end, turn architects into *mere technicians,* making pretty pictures to be implemented with automated tools. On the other hand, the well-crafted machine drawing, the innovative implementation of a script, or the innovative and collaborative fabrication project were all treated with admiration and respect by respondents. They valued these for the quality and innovation they represent.

Technology has a vital role in the design studio, but the role of the design studio is not to promote or even teach the use of technologies. Technologies remain only one of a number of tools in the architect's arsenal to be used, but also critiqued, for their role in the design. Ultimately, control of the design—and the imposition of meaning—remains the task of the designer.

The final question of technology in the architectural pedagogy is what the future holds. Some of the participants had truly unique visions of transhumanism and virtuality: people designing from all over, being *in* a place without being in it, and the integration of human and machine intelligence. These visions are inspiring, but it is uncertain when or how they may be integrated. In the near term, most of the participants envision more tools, more diverse tools, and a greater role of architects as *toolmakers* as well as *tool users* as a future direction. This vision does not involve a radical change in the use of technology, but instead represents a gradual change in the role of technology and the integration of technologies as a diverse spectrum of tools into architects' ways of working.

This shift will occur regardless of changes in epistemology and formal curriculum management as the digital natives begin to take over from the digital immigrants. As the professional pressure to introduce tools and technologies begins to become generalized from demands for specific tools (such as BIM) to the need for architects who can learn to use any technology, the shift will take place. Thus, over time the use of technology will become increasingly unremarked, simply a way of working, rather than something considered to be new and/or different.

The implications of this shift are inherently complicated and should be considered carefully. In the end, however, this change will happen, simply due to the existing experience of architecture students and teachers. It is therefore important for architectural pedagogy to confront the problem of technology now and to begin to develop ways to critique and integrate advanced technologies gracefully into the epistemologies and ontologies used in the seminar and design studio. As Ronnie Parsons remarked in his interview, it is not sensible to expect an epistemology and approach to technology developed in an early age, such as the 19th century, to suffice for a contemporary architectural practice in the 21st century. This observation will become no less true as time goes on, and as such, this must be a constant area of critique and development in order for architectural curriculum to remain fresh and relevant.

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APPENDIX A:

PARTICIPANT LIST AND BIOGRAPHIES

Table 2. Participants in the research process

Participant	Region	Institutional Affiliations, Academic Position(s) and Professional Positions
Bruce Lindsey	Missouri	Washington University, St. Louis *Dean, College of Architecture (Graduate School of Architecture and Design)* *E. Desmond Lee Professor for Community Collaboration*
Darren Petrucci	Arizona	Arizona State University School of Design *SunCor Professor of Architecture and Urban Design*
David Gersten	New York	Cooper Union Irwin S. Chanin School of Architecture *Professor*
David Jason Gerber	Los Angeles	University of Southern California (USC) *Assistant Professor of Architecture*
Evan Douglis	Troy, NY	Rensselaer School of Architecture, Rensselaer Polytechnic Institute *Dean* *Professor* *Principal architect, Evan Douglis Studio*
Elizabeth O'Donnell	New York	Cooper Union *Assistant Dean and Professor*
Gil Akos	New York	Pratt Institute *Visiting Assistant Professor* *Designer/Partner, Studio Mode*
Greg Lynn	Los Angeles	University of California Los Angeles (UCLA) School of Architecture and Urban Design *Professor* *Principal, Greg Lynn Form*
Jason Griffiths	Arizona	Arizona State University (ASU) Herberger Institute for Design and the Arts *Assistant Professor* *Partner, Gino Griffiths Architects*
Jason Kelly Johnson	California	California College of the Arts (CCA) *Assistant Professor* *Founder and Partner, Future Design Lab*
Mohsen Mostafavi	Boston	Harvard University School of Design *Dean of the Faculty of Design* *Alexander and Victoria Wiley Professor of Design*
Nader Tehrani	Boston	Massachusetts Institute of Technology (MIT) School of Architecture and Planning *Professor and Head of the Department of Architecture* *Principal and Founder of NADAAA*

Participant	Region	Institutional Affiliations, Academic Position(s) and Professional Positions
Omar Khan	Buffalo, NY	University of Buffalo School of Architecture and Planning *Associate Professor and Chair*
Phillip Anzalone	New York	Columbia University Director of the Building Technologies Sequence
Skylar Tibbits	Boston	MIT School of Architecture and Planning *Lecturer* *SJET LLC (Founder)*
Thom Faulders	California	California College of the Arts (CCA) *Associate Professor* *Founder, Faulders Studio*
William MacDonald	New York	Pratt Institute *Chairperson of Graduate Architecture*

Biographies

Bruce Lindsey is Dean of the College of Architecture in the Graduate School of Architecture and Design at Washington University in St. Louis, Missouri. He is also the E. Desmond Lee Professor for Community Collaboration and is a practicing architect. Lindsey received an M.Arch from Yale University, and he holds an MFA in sculpture & photography and a BFA in art from the University of Utah. He has been honored with several awards for his work, including the Young Architects Award from *Progressive Architecture*, American Institute of Architects (AIA) Design Honor Award, and AIA's National Teaching Honor Award.

Darren Petrucci is the founder and principal of A-I-R [Architecture-Infrastructure-Research] Inc. and is a Professor of Architecture and Urban Design at Arizona State University. At ASU, Petrucci manages SCAPE (Systems Components Architectural Products + Environments), an applied research lab. He holds two master's degrees, one in architecture and another in architecture and urban design from Harvard's Graduate School of Design. He has been honored with a *New York Architecture League's* "Emerging Voices" award, a *Progressive Architecture Award*, and two *NCARB Prizes* for excellence in teaching and practice.

David Gersten has been a Professor in New York's Cooper Union Irwin S. Chanin School of Architecture for over 20 years and is the Associate Dean and Acting Dean of the School of Architecture. During his career Gersten has taught nationally and abroad at universities in Bolivia, Argentina, Denmark, and Spain. He co-founded Maimar LLC, a multidisciplinary finance and development company, founded and served as President and CEO of a design and build company Tree-Time Workshop, Inc., and has worked on projects for PBS Television, the Intrepid Air and Space Museum, The New York Stock Exchange, and Sony, among others.

David Jason Gerber is an executive at Gehry Technologies Inc. and Assistant Professor of Architecture at the University of Southern California (USC) in Los Angeles. He earned his B.A. at U.C. Berkley, his M.Arch. at the Architectural Association in London, and his M.Des.S. and D.Des. from Harvard University. Gerber has taught at the Southern California Institute of Architecture, the Architectural Association's Design Research Laboratory in London, Innsbruck University, and the EPFL Switzerland, and he has worked on multiple projects while at Zaha Hadid Architects.

Evan Douglis is the principal architect at the Evan Douglis Studio and is Professor and Dean of the Rensselaer School of Architecture at Rensselaer Polytechnic Institute. He was previously the Chair of the undergraduate department at Pratt, Associate Assistant Professor and Director of Architecture Galleries at Columbia University, and a visiting instructor at the Irwin S. Chanin School of Architecture at Cooper Union. He has been honored with numerous awards in the field including an NYFA fellowship, an FEIDAD Design Merit Award, and an AIA/LA People's Restaurant Choice Award.

Elizabeth O'Donnell is the Assistant Dean and Professor in the Irwin S. Chanin School of Architecture at Cooper Union in New York. She has been teaching in the department for nearly 30 years and received here degree there after studying at the University of Minnesota and Antioch College. O'Donnell has won awards for Design Excellence from the NYC American Institute of Architects and Design Distinction from International Design magazine. Her professional work focuses on adaptive reuse of buildings and she has completed projects for high profile clients including Yoko Ono and Tadashi Kawamata.

Gil Akos is the founder and partner of Studio Mode, a Brooklyn-based design studio and research collective, and is a Visiting Assistant Professor at New York's Pratt Institute. He holds an M.S. in advanced architectural design from Columbia University and an M.Arch from the University of Kansas. Akos has taught at Columbia and Princeton and specializes in architectural design, interface design, digital fabrication, code-based procedures, parametric modeling, design integration, and design implementation.

Greg Lynn has been a faculty member in the University of California Los Angeles (UCLA) School of Architecture & Urban Design since 1996. He is also a Master Professor at the University of Applied Arts in Vienna and the Davenport Visiting Professor at Yale University. He received bachelor's degrees in architecture and philosophy from Miami University of Ohio, an M.Arch from Princeton, and an honorary doctorate degree from the Academy of Fine Arts & Design in Bratislava. Lynn was named a top ten trendsetter in architecture by *Forbes* Magazine and one of the top 100 most important people of the 21st century by *Time Magazine*.

Jason Griffiths is a partner at Gino Griffiths Architects and is an Assistant Professor at the Arizona State University (ASU) Herberger Institute for Design and the Arts. He earned his M.Arch at UCL Bartlett in London and has been teaching architecture since 1994, starting at Oxford Brookes and the University of Westminster. He has won numerous awards for his work, including the Millennium Café competition, Future Visions of Kyoto, Shinkenchiku Residential Design (three times), and the Oklahoma Memorial.

Jason Kelly Johnson is the founder and partner of Future Cities Lab, a San Francisco-based experimental design and research office. He is also an Assistant Professor in the Graduate Program in Design and the Architecture Program at California College of the Arts (CCA). He received a B.A. from the University of Virginia and an M.Arch from Princeton. Johnson has previously taught at the University of Virginia and the University of Pennsylvania. Future Cities Lab has been awarded several honors, including the Van Alen New York Prize and an Unbuilt Architecture Award from the Boston AIA.

Mohsen Mostafavi is the Dean of the Faculty of Design and the Alexander and Victoria Wiley Professor of Design in Harvard University's School of Design. He received his degrees from the University of Essex and Cambridge and has taught at numerous institutions both in the United States and abroad, including the University of Pennsylvania, Cornell, Cambridge, and the Frankfurt Academy of Fine Arts. He was Chairman for the Architectural Association School of Architecture from 1995 to 2004. Mostafavi has received several awards and grants for his work, including the CICA Bruno Zevi Book Award for Surface Architecture, Graham Foundation Grant for Research on Architecture and Drawing Representation, and the Vienna Competition Prize.

Nader Tehrani is the principal and founder of NADAAA and is also Professor and Head of the Department of Architecture at the Massachusetts Institute of Technology (MIT) School of Architecture and Planning. He received bachelor's degrees in architecture and fine arts from RISD, completed a post-graduate program in the Architectural Association's Graduate School of History and Theory, and earned his M.Arch in urban design from Harvard University's Graduate School of Design. As a practicing architect, Tehrani has won awards for projects including the Tongxian Art Gatehouse in Beijing, Fleet Library at RISD, the Multi-faith Spiritual Center at Northeastern University, and the LEED-Gold certified Macallen Building in Boston.

Omar Khan is the co-founder of Liminal Projects. He is also an Associate Professor and Chair of the University of Buffalo School of Architecture and Planning, where he co-directs the Center for Architecture and Situated Technologies. He was educated at MIT and Cornell University and has been recognized for his work and awarded grants by the New York Council for the Arts, the Department of Education, the Rockefeller Foundation, and the New York Foundation for the Arts.

Phillip Anzalone is a principal at the Brooklyn-based Atelier Architecture 64 and is also the Director of the Building Technologies Sequence and Avery Digital Fabrication Laboratory at Columbia University's Graduate School of Architecture, Planning, and Preservation. He has also served as a Visiting Assistant Professor at Pratt Institute. Anzalone received an M.Arch from Columbia University and a B.P.S in Architecture from State University of New York at Buffalo.

Ronnie Parsons is a founding partner at Studio Mode and an Assistant Professor at New York's Pratt Institute. He received an M.S. of architecture from Ohio State University Knowlton School of Architecture and a B.S. in architecture from the University of Texas at Arlington. Parsons has served as adjunct faculty at the Stevens Institute of Technology Product Architecture Lab and the City College of New York.

Skylar Tibbits is the founder and principal of SJET LLC, a multidisciplinary research-based practice, and is a lecturer at MIT's School of Architecture and Planning. He received both his SMArchS in Design and Computation and MA/SM in Computer Science from MIT. Tibbits has exhibited work around the world, has been awarded

TED2011 and TED2012 Fellowships, and was named a Revolutionary Mind by SEED Magazine.

Thom Faulders is the founder of Faulders Studio, an architecture and design office in San Francisco, and he is an Associate Professor at the California College of the Arts (CCA). He obtained a B.Arch from California Polytechnic State University San Luis Obispo and an M.Arch from the Cranbrook Academy of Art. Faulders was the recipient of an *Emerging Architect Award* from the Architectural League of New York and the winner of the *SFMOMA Experimental Design Award*. Faulders Studio has won numerous project awards, including the San Francisco Bay Conservation and Development Commission's *Rising Tides Competition*, a *New Practices Award* from the San Francisco AIA, and a *Top 25 International Projects* award for Private Plots International Competition in Austria.

William MacDonald is a Professor and Chair of Graduate Architecture at New York's Pratt Institute. He received an M.S. in architecture and urban design at Columbia University and a B.Arch from Syracuse. He has taught at a number of architecture schools during his career, including the University of Pennsylvania, Southern California Institute for Architecture, the University of Virginia, Ohio State University, the City College of New York, and the University of California Berkley. MacDonald has also received numerous awards and honors for academic and professional work including the "40 under 40" award, Progressive Architecture awards, and AIA design awards.

APPENDIX B:

SEMI-GUIDED INTERVIEW TRANSCRIPTS

1) Bruce Lindsey

Interviewer: Regarding the influence of technology in contemporary architectural education:

Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school (Washington University in St. Louis)?

Bruce Lindsey: Yes, very much so, and it has for a long time.

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school?

Bruce Lindsey: In the last several years we've been developing a digital fabrication initiative that uses digital technology to help fabricate not only full-scale projects but facilitate in the development of models and details for design projects.

Interviewer: Some schools adopt an information theory paradigm, others a general system theory into their pedagogy, the way they teach architecture?

Bruce Lindsey: No, I would say that we don't have very many courses that address the theoretical issues of technology or pedagogy. Although we just recently adopted a new master's of science program, and one of the areas of focus is architectural pedagogy. So we'll have two students that will be joining us this fall, two master students that will be working on a master's of science degree in architectural pedagogy.

Interviewer: Then there is no specific paradigm or theoretical framework that you're using digital technology under?

Bruce Lindsey: Yeah, I would say it's not an explicit theoretical framework. I think the work that we've been doing in the last few years has been centered on working with the students to be able to use the computer to get things out into the real world, in other words to make models, fabricate, and to explore full-scale projects. Prior to that I would say the school like many other schools was using digital technology primarily in the area of digitalization, but also with the last couple of years we've developed several new classes and several focus studios on the role of environmental simulation and the analysis of building performance using software tools.

Interviewer: How are they integrated into the curriculum?

Bruce Lindsey: Yes, I'm primarily talking about a graduate program now, which is the professional program. We have two environmental systems courses, and in the first course the students are introduced to [software tools] and the second course they carry that forward to a little greater degree. We also have elective coursework in building information modeling and two advanced seminar courses in the use of environmental simulation software. That course is taught by a grad student who is in practice using that – this fall we'll have an option[al] graduate studio focused specifically on the use of those tools; that's being taught by an architect from Chicago.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

Bruce Lindsey: Ironically the digital technology was introduced to the school of architecture through the urban design program, probably 15 years ago. And it was done through a grant that the urban design research center had, and for a long time in this school digital technology was a lab that was associated with the urban design program. So in some regards our school has been late to the game in developing and implementing the use of digital technology within the architecture curriculum, although we've had several faculty over the last 10 years who have been excellent proponents of that.

Interviewer: What do you think are the positive and negative implications of this?

Bruce Lindsey: The positive is that of course myself and the faculty feel that it's a crucial aspect of the education of architects, and so we've been putting a good deal of effort and money into it over the last five years, especially since I've been here. My own experience is a little different, however, right? I've been involved in the implementation of architectural pedagogy around digital technology since 1990. I was asked to integrate computer technology into the freshmen design sequence in Carnegie Mellon University in 1990.

Interviewer: Do you see any negatives?

Bruce Lindsey: The only negative that I see with that kind of historical perspective is that people are still talking about questions that I thought were answered 50 years ago, like when should the computer be introduced, should it be introduced, how and that kind of thing. And for 15 years now I've said that the students are coming in with computers; you either teach it or they're going to use it on their own because they know they will need to. And so those kinds of questions to me get in the way of being more innovative, more experimental, and more specific and explicit about how we integrate it into the curriculum.

Interviewer: How do you believe technological models shaped architectural pedagogy historically? Shaped the critical thinking in architectural education?

Bruce Lindsey: I think in some ways it's got in the way. It's become a kind of focus of attention in and of itself, and so I think to some degree I would argue that most schools have not dealt with any kind of theoretical framework around which digital technology could be applied or understood or explored. Some schools, of course, do research in this area, and I think all of that's interesting. I don't know if many schools that are doing research into the application – or the pedagogy of these tools other than discussions within the faculty themselves around what I would call fairly mundane questions about digital technology.

For instance, [the] undergraduate program didn't introduce computers until the third year. We changed all of that, and now computers are introduced in the first semester alongside traditional kinds of representation and modeling tools. And I still talk to colleagues around the country that are – that have the attitude – the argument of that now you are to limit the effectiveness of other traditional media, and it's always at the expense of something else. And I think all of that is wrong.

Digital technology is a part of architectural practice, and it needs to be better understood as a required part of architectural pedagogy.

Interviewer: When you said introducing computers to the undergraduate in their first semester, did you mean programming, scripting, a specific software or fabrication?

Bruce Lindsey: I think there was a time 15 years ago, maybe 12 years ago, when schools of architecture were leading the way in the use of digital technology, particularly in the area of digitalization. I think to some degree scripting and parametric design is again coming full strength from some programs within the university in a way to practice. I don't see a lot of practices that are experimenting with ways to use that. Quite frankly I think our students bring that with them to offices, and an example of that is Cannon Design. They have a – in this case, it's not one of our students but it's a global practice with 20 some offices – they have one here in St. Louis.

They hired a young architect from the AA school who is very skillful in scripting and using Grasshopper and Rhino and parametric modeling. And he's brought that to that office; it didn't come from the office. So in the last few years around scripting and the more experimental aspects of the use of digital tools, I would say schools are starting to begin to lead the way again.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? How?

Bruce Lindsey: Yes, I think so. I think quickly scripting and the more advanced things that we're seeing being done right now will become come part of practice fairly quickly. And I would imagine schools will be on something else at that point, so I don't know what's going to happen.

I tend to see this oscillation between digital technology being led by the schools and being led by practice. I would say right now building information modeling has really grown from practice and not from the schools. They've been skeptical of its value in part because of the role of construction and the experience of teaching construction, and [in] schools [building information modeling] does not – doesn't happen very much or in very many places.

Interviewer: And this is an argument that today practice is shaping pedagogy where a decade ago pedagogy used to shape the practice.

Bruce Lindsey: Yes. I would say that's true, but again, very quickly the use of digital tools became in some ways especially – well I would say that in regard to environmental simulation software and environmental modeling that I think became more significantly a part of practice, and it wasn't being taught in school. And I think that's because of the schools in general being slow on the uptake around issues of sustainability and of being more obsessed with the formal aspects of design and the design studio.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

Bruce Lindsey: I think one of the things that has happened and will continue to be significant is the role of the computer as a collaborative platform or environment. Building information modeling is a part of that, but I think that increasingly technology enables new kinds of practice relationships between a diverse set of not only practitioners or not only between architects, designers, engineers, and the team within the design groups.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of your school?

Bruce Lindsey: Well, it has been changing that for a long time. In 1991, we did a remote collaborative studio with a group of students in [a city in] Mexico from our studios in Pittsburgh, and so that was an interesting phenomenon around the early use of, at that time, fairly crude collaborative software like fax machines and email and video conferences. I think that's going to come back; I think you're going to see not only joint studios like that happening, but you're going to see – or we already are seeing – joint studios that are being taught by faculty who come visit here, but more often than not connected with the students remotely. So we have a strong visiting professor program, and they fly in for two days a week generally, but they stay in contact with the students the other days of the week remotely. And I think that's going to become a strong way in which schools are able to tap into not only a diverse set of professors and experiences but also a global set of opportunities.

Our school now is for the first time 50% international students, and we think that's great. And so we're looking at ways – we have a long tradition to bring in faculty from around the world – but we're looking for ways to facilitate that. And also to do it without breaking the bank because recently cost of airfare has been through the roof, and it's not exactly a sustainable way to bring people in.

Interviewer: Do faculty at your school create blogs or websites to post tutorials, discussions, or for the students to post their projects?

Bruce Lindsey: Some do; I would say most don't. The university has been also a little slow in centralizing those kinds of services. They just implemented – the university just implemented the use of a course software called Blackboard which has been used by many universities for a long, long time. The system that they have replaced was fairly crude, so I would say our faculty are not really up to speed on all of that. It's more of the faculty that comes in to teach that are starting to use that kind of thing, or starting to encourage their use of them.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Bruce Lindsey: Within the studio. I would say almost every design studio now has some degree of collaborative team-based work – almost every studio. And that's certainly facilitated among the students through the use of technology. Again, I don't know that that's explicit in the way that our faculty organize the design studio. I think it should be – I mean, again, 15 years ago there were architects involved in their research projects at Carnegie Mellon University, and they were all about that. Theirs is a little bit of an unusual environment, though, because of the – the PhD program that was a part of the school that was doing some significant research with computers at Carnegie Mellon; it was the first PhD in computer-aided design (CAD) in the country.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Bruce Lindsey: Oh, I think positively. I think we also have a studio culture that allows for it to be a positive and not a negative. The students still work in studios; the social environment of the studio is critical, and it's valued by the faculty. And so that's maintained, and I've never seen any influence or evidence to suggest that the use of digital collaborative environments negatively impacts that. The students don't go home and work – well, they do, but they continue to work in the studio, which is a good thing.

One thing that's been great is that in terms of blogs and things we have a number of international studios, and those – they all have blogs, and it keeps the students connected with the students at the field and also at the same time promotes the program. We have students in Barcelona right now. Tomorrow I'm going to Shanghai where urban design students are. In the fall we have students in Buenos Aires, South Korea, Spain, Helsinki – and so all of those programs keep connected through student-run blogs and websites.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Bruce Lindsey: Well, I actually think again we're going to probably be doing things that we did 15 years ago, which is using the technology to have joint studios with other schools. We're doing that now physically, and I think that we'll probably be doing it virtually in the near future. I think that as younger faculty come in, their familiarity with being explicit about those kinds of things and the design of the studio and their coursework is going to increase, and it will lead to, I think, a stronger integration and a degree of exploration around the pedagogy of using tools.

We're seeing that in a way, in the way that our faculty practice. They're teaming with colleagues that are around the country; they are in competitions and using that as a part of their – the way that they practice as a professor, and I think that's an interesting phenomenon. Our faculty are also practicing in Indonesia and in South America and in China and across the United States.

Interviewer: So they teach the design studio online, but they have to come to the school for about two days?

Bruce Lindsey: Yeah, typically, but I think that's going to – I think we're going to have variations on that where a faculty member that we want to be a part of the school who is coming from Copenhagen, for instance, comes fewer times and connects remotely. We have a faculty member in our urban design program whose practice is in Copenhagen, and he now flies three or four times in the spring semester. And I think if we want to keep that connection – the students go and visit there as well, but I think we're going to be utilizing remote tools more extensively in those kinds of studios because of the value that we see in those kinds of faculty and their practices being a part of the school.

Interviewer: Do they communicate via Skype?

Bruce Lindsey: Yeah, everything that they need. In addition, this fall, for instance, we're doing a studio that involves HOK office. They sit in the office for this studio, and they have a very sophisticated digital collaborative studio in the sense it connects all of the offices that they have. So the students are going to utilize that as a part of their design studio. They'll be talking to consultants in Chicago and Shanghai and the other HOK offices around the world, using that facility in their office.

We still believe that you have to come to the studio, that you can't replace that personal contact in connection but you can extend it.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage and question technology/technological paradigms within the design studio? How so?

Bruce Lindsey: I would say we do that in the digital fabrication studios but not in the other design studios. I would say that the students first of all are fairly fluent and comfortable with technology, so it doesn't – except in some very specific studios – become an explicit part of the exploration. We have a wide variety of studios in the optional section of our curriculum, however, and some studios do do that. I would say they're typically foreign visitors, and we've had a digital fabrication studio every semester over the last three years, so that's brought a mix of different faculty. And in that studio I would say that probably three-quarters of the studios are explicitly experimenting with things like scripting and/or different types of fabrication, different kinds of materials that are sort of understood in the context of their potential relative to the digital fabrication equipment we have.

One of the projects was in the community, and that community-based interaction, community meetings, and things were also to take through very extensive visualization and kind of model-making that allowed the community to understand a fairly experimental project in a very real way, and that, I think, led to the comfort level of the community and allowing the project to go forward.

And then in our degree project, which is the thesis part of our curriculum, I would say that the expectation is that students are fluent with all forms of three-dimensional modeling and visualization. Increasingly the students are beginning to bring in environmental simulation as a part of that because of some of the courses that we've been doing and in fact that we have some faculty that can support the interest of that. So I'd say that's a growing part of being with the students.

Interviewer: I've attended some juries, and in some of the students' projects boards you'll see a Grasshopper definition as a part of their design process to get the form that they have. Do you think by having that scripting diagram the student used digital technology critically?

Bruce Lindsey: Well, I think one of the problems with that – I don't think they're doing that by the way, and I think a few faculty are – a few people are out there thinking about that. I think that part of the reason is, is that we think of it as a tool; I think that's a mistake. I think if it's a tool then it's a lot of tools, and we don't typically think of our tools critically, or we don't think of them as having a kind of theoretical history and/or potential in a way that they could lead to a new kind of architect.

I think the area where I see that sort of emerging as a possibility is in the way in which environmental simulation and modeling is allowing for a kind of justification, if you will, for a new form of expression in architecture, a new kind of dynamic relationship between building and the environment, and I think that has a great deal of potential and that will require some critical exploration.

Interviewer: Do you believe we need to teach the students the theory or history aspects of using these digital technologies in their design or design thinking?

Bruce Lindsey: Yeah, I think we do, yeah.

Interviewer: In the design studio or in a different class?

Bruce Lindsey: Yes, in a different class, yes.

Interviewer: Do you do that in your school?

Bruce Lindsey: Yeah, I would say that, in the area of that, the theory related to digital technology is a wide open field with very little being done that I can see right now. In fact, 15 years ago there was more of it, I would say, than there is now, but some other similar debates as I mentioned are still going on, so I don't understand that.

Interviewer: Back in the German Bauhaus or the Russian Vkhutemas, both hold a constructivist theory and philosophy in teaching art and design. You can see that in their work they had a specific look and aesthetic. Today, I sense that we're missing that. A lot of the architecture schools produce the same projects because they are using the same tools; it's hard to distinguish one school work from another!

Bruce Lindsey: Right. Yeah, I mean there is another thing, too, which is that there is a rhetoric relative/related to digital design that suggests that kind of infinite mutability, and yet the projects have a very similar kind of stylistic tendency. In other words, part of the promise of some of the tools and ideas is that they're specific, and if that's the case, why do they all look alike?

So I don't think that's the problem particular to digital technology. I think it's more of a human issue, not a technology issue.

Interviewer: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Bruce Lindsey: No, I don't think it does, but it should. I don't think that they're seeing it in our schools having much relationship to each other, I would say.

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Bruce Lindsey: 10% use advanced visualization of some form or another.

Interviewer: What are the primary factors that you believe may hold back those 90% faculty members who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

Bruce Lindsey: They don't know how to use the tools.

Interviewer: Do you think it's a generational issue?

Bruce Lindsey: Yes, partially. Our school also has a strong tradition of educating students towards practice, so I would say that in the spectrum of architectural pedagogy, we're kind of right down the middle of the road.

Interviewer: Do your faculty members, the 10%, think critically about how digital technologies affect the possibilities of architectural representation?

Bruce Lindsey: Certainly more critically than their colleagues. Again, I think the area that seems to be the most carefully understood in terms of pedagogy is fabrication models. The value in the physical artifact and search and the experimentation that uses the current tools that we have to output artifacts in a way that sort of allows them to be better understood and be a part of a kind of material exploration – that is important. So I think in that area, certainly – less so in the area of parametric modeling and even less so in the area of environmental simulation.

There is an interest, though, in our urban design program around ideas of urban simulation. And I think, again, it's kind of interesting to think back that the origin of digital technology in the school was in the urban design program.

Interviewer: Do you have a class dedicated to experimentation with materials?

Bruce Lindsey: Yeah, several. And I would say that they typically use digital fabrication [as] part of that.

Interviewer: Some schools have a foundational course that is similar to the basic course at the Bauhaus in their first year. Do you have a foundation course?

Bruce Lindsey: Yes, from the '50s through the '80s I would say that our undergraduate program especially was very strongly influenced by the foundation programs of the Bauhaus. One of the key faculty actually was a student of some of the original Bauhaus members that went to IIT in Chicago, and the fact that the school had a relationship to the school of art has been a strong part of that. I would say that its foundation in Bauhaus pedagogy was probably stronger in the '80s than it is now, but it's still there, and increasingly so around what have been the initiatives of the new Sam Fox School, which is about bringing art and architecture together.

And so our freshmen now have a shared foundation, and as I mentioned the introduction of the computers is specifically explicit to that pedagogy. So that curriculum in the coordination of our core's done, or is now in the hands of one of the faculty who 10 years ago was one of the only proponents of digital technology in the school. And so he organized the first four semesters [to be] a kind of alternation between hand techniques of making and material exploration and digitally developed ideas around not only modeling in visualization but fabrication. So the students will be doing that for the first two years.

The projects of that are sometimes not necessarily architectural, so in a way that's kind of back to the '80s when I would say the things like color theory and material exploration coming from Bauhaus were strong. So we see that coming back a bit.

Interviewer: So they do geometric studies as well like, like the Bauhaus?

Bruce Lindsey: Yeah it's funny that the fascination with geometry and architects has never left; it just becomes historically separated from the fascination of geometry when you talk about geometry relative to digital modeling. I think the younger architects don't get the history of that, although they're talking about it all the time.

Interviewer: What about the issue of shared-authorship, since the students are collaboratively working on projects?

Bruce Lindsey: Yeah, well the faculty are still in the Middle Ages around that issue. They still see it as a problem, rather than as a possibility of the tool. Interestingly enough one of the recent new members of the law faculty here at Washington University considered to be one of the top patent lawyers in the country has an M.Arch degree and worked for Bernard Tschumi for five years before he went to law school.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Bruce Lindsey: Yeah sure, I mean I think that it took a kind of active part of the administration to put the money forward to develop the digital fabrication initiative. So certainly the financial aspects of that have been a problem. Most recently we've been concerned about – well, we've begun to require that students have their own computer, which we did at Carnegie Mellon 15 years ago, but here it's – just in the last year – been a part of the expectation. Although most students did come with computers, we're now being explicit about their need to have one. And we've been sensitive to the cost of that changing ways in which, for instance, Microsoft is licensing software to the students, and it's been a challenge for sure.

Interviewer: But you do have computer labs at the school for the students to use, right?

Bruce Lindsey: Yeah, we do, and we've been talking about getting rid of them.

Interviewer: Why?

Bruce Lindsey: Well, first of all there is a sense that in the context of a crowded curriculum in the master of architecture program you no longer teach software; you would teach the theory course around digital technology rather than teach a software course. So the use of the lab as a teaching space is changing. If the students come in with their own laptops, there is a sense that the – we only have two labs, small labs actually, and so we've been talking about getting rid of them.

Interviewer: But you do still teach the student software like Rhino, Grasshopper?

Bruce Lindsey: Yeah we do it through workshops primarily, and the students teach each other better than typically we can teach them. I say that a little bit facetiously because we still do teach software to some degree. Some of the advanced seminar electives that I was mentioning get deep into that. We have several courses that are doing pretty advanced stuff in building information modeling in parametric designs, but in general, I would say that there is an expectation that the students teach each other the software.

Interviewer: What are the theory classes that you teach re: digital technology?

Bruce Lindsey: There is one called Adaptive Skins and its building enclosure – it's about developing building enclosure systems using parametric modeling and environmental simulation software. And these are both taught by the same guy. And there is another one that's – I forget the name of it – but it's the introduction into environmental modeling software.

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Bruce Lindsey: Sure, everybody wants us to teach BIM – Revit, basically, so we give Revit workshops. And we're under increasing pressure in part from the students who are out there trying to find a job in a difficult market, and they go for an interview and they don't get in the front door if they don't know Revit software.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Bruce Lindsey: When we started, when we worked on the program at Carnegie Mellon in 1990, we had an attitude wherein we wouldn't teach software programs; we would teach software paradigms. And so at that time, for instance, there was a 3D modeling software that's very new, and there was a general distinction between surface modelers and solid modelers. And so we would teach the difference in the approach to those kinds of software rather than teaching at that time – you won't know these names, but – Architrion or Form-Z.

Interviewer: I'm familiar with Form-Z.

Bruce Lindsey: But not Architrion though, I bet, or Super 3D, which was the very first three-dimensional modeling program that I was aware of – this was 1989 and only ran on a Macintosh. So, we had an introductory theory class in the first year of that curriculum that was about those kind of things, and that again is part of my frustration around things like some of the questions you're asking relative to the teaching of the theory of digital technology. At that time it was new, so there was a sense of the need to understand it correctly. And I think as it's become more widely understood as a part of digitalization rather than something that has theoretical implications. I would say it's kind of become marginal in some ways.

Interviewer: You want the student to think about using digital technologies in a deeper way – the history, the theory, the math – it's not about creating a cool looking form. It's about the whys.

Bruce Lindsey: Yeah. I think it's not just related to digital technology. I would say that in the technical aspects of architecture, in particular, being pushed by the need for sustainable design – sustainable strategies to deal with environmental problems – requires a greater depth in technical issues than I think, for architects, demands it. So that's something we've been cognizant of and are trying to find a way to, in a way, build that experience within our students. It's not just related to digital technology. I think students need to know more about how buildings are built to be able to design them more sustainably. They certainly need to know more about how they perform to be able to project new strategies for how buildings could perform.

Interviewer: Like the concept of biomimicry in architecture—

Bruce Lindsey: Right, yeah, we have an excellent class in biomimicry that's taught by one of our faculty members. It's a fantastic course.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Bruce Lindsey: I think the potential for environmental modeling [is] to open up a new form of expression for architecture – in other words, to change our minds about what buildings might look like and how they might work. I don't think we've done that. I think that the formal aspects of architecture remain a product of something outside the way the building performs and outside a kind of theoretical understanding of a kind of way in which the building is a part of its context – in particular, its environment. And that extends to the idea of urban design modeling, even understanding the role of buildings within the city. So I think digital technology has the potential to lead us to a new form of the aesthetics in architecture. And I see that as being wide open territory.

Interviewer: Do you see it right now, that change in aesthetics because of digital technology?

Bruce Lindsey: No, I don't. If I did I wouldn't be able to see – or I would expect for the kinds of expressions that come from the use of technology to be much more varied than they are. So something else is at work; it's a kind of fascination with, for instance, a kind of reaction against the orthogonal in architecture. Why is it we never see a parametric building that's a beautiful box? Why is it that the kinds of use of technology almost always tend towards the complex rather than the simple? Or why your [result] seems to be disconnected typically from modeling software. Shouldn't there be a modeling tool that comes from environmental simulation, rather than it being applied to a model to test or to suggest the ultimate?

I think that in terms of scripting and advanced programming I would want to see parametric modeling that comes from weather data or environmental modeling rather than from a kind of attitude about building construction.

I think the machine is an analog for architecture that died 15 years ago, and again architecture is sort of 15 years behind science, where 50 years ago biology emerged as a primary paradigm of science. I think we're starting to see that trickle down into architecture.

For instance, one of the faculty that we had here last spring, who's been for the last five years interested in scripting in parametric modeling and digital fabrication, came in and was talking to the students about making skin using an inkjet printer. I think that's pretty interesting.

Interviewer: Did they create the skin?

Bruce Lindsey: He has done it, yes. The students didn't, but he was talking to them about it. That's something he is working on right now.

This architect is from New York, and he shares a studio with a small startup company that's actually using old HP printers. It is a particular printer they can only get on eBay because printers have become too sophisticated now, and the printers that they want need a nozzle size that is exactly right for a cell size. And so the new ones are too small, but the old ones that they get off eBay can actually print cells and print skin, and that's what they're working on. And so he got to know these guys, and the curious architect began to speculate about the potential of this relative to his fascination of digital technology.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Bruce Lindsey: No, but there was something that I saw. I was at a symposium in the middle '90s and the symposium was celebrating the 90th birthday of Herb Simon. I don't know if you know Herb Simon's work, but he was the pioneer among many things in the early development of computers in the '50s, and he was using them to test theories of cognition, in other words speculations about how we think. He is often cited as in some ways founding the field of cognitive psychology, and he went on to win the Noble Prize in economics based on his sort of study of how we think. And he was using computers to kind of test his theories of our brain. And so one of the people speaking at the symposium was David Gelernter – do you know his works?

He has a book, among others, called *Machine Beauty*, and he is a professor of computer science at Yale University. But is most famously probably known as one of the targets of the Unabomber; he lost part of his hands when he opened a package that exploded. You know about the Unabomber? [He was] a terrorist in the United States who for over a period of 15 years sent letter bombs to people. And they finally caught him, and he had written this long, long diatribe about technology. And so basically the theme of this symposium was "*so what?*" And Gelernter said, "When all is said and done, will computers or digital technology help us answer any of the larger questions?" He said, "No, probably not, but it remains the case that they fascinate." Sometimes I think that's enough as long as it keeps fascinating us. He used his child as an example, as someone who sort of had a different relationship with technology than he did. That's always been one of the most driving factors in my sort of understanding of it – that it's just fascinating, the various potential of how our tools influence what we can do. And so it continues to do that.

Interviewer: And that's the reason for me to do this research. I'm fascinated by digital technology. Thanks again, Professor Lindsey, for your time and help.

Bruce Lindsey: You're welcome.

2) Darren Petrucci

Interviewer: Regarding the influence of technology in contemporary architecture education, do models/paradigms associated with digital technology shape or inform the pedagogy at your school?

Darren Petrucci: Okay. It's a good question. I would say here at ASU we're on the cusp of engaging digital technologies as they relate to design. We've been very careful to not just jump on the bandwagon of parametricism that's happening everywhere, mostly through Grasshopper and Rhino as a particular technology, because of what we're trying to do – and I think it's important for each school to leverage its unique differentiators vis-a-vis that technology. For example, Columbia, which in the '90s built its reputation on computer technologies and visualization and illustration, really was the forefronter of that technology nationally. They are always going to be doing that and are very good at it and have a long legacy doing it, so that's not something we should be dealing with right now. But here in Arizona, for example, we have very significant differentiators; one, we have a design school of multiple disciplines, so it's not just architecture.

We also have a climatic condition which helps us to focus the design teaching that we deal with so that students are constantly aware of sustainable practices, optimization of design, severity of climate use, etc. So what we've started to do is we've started a studio in the fall of the graduate program called the light studio, and the intention is that the subject of the studio is light in all of its manifestations; so that could be literally day lighting or artificial lighting, but more importantly things that light produces like heat, glare, thermal qualities of it, the possibility of it from a energy producing situation. And then the question is how do we use these new digital tools to integrate multiple variables within the tool. So less is it an illustrative method of coming up with new formal designs for the sake of formalism, but more understanding how the digital tools can take multiple variables and help us come up with forms that integrate those variables.

So if I'm looking at the angle of incidence of the sun, a particular material quality – or maybe it's a steel or something – and the program, I've got three variables that I can now plug into my model and begin to understand how I can manipulate that form to be more innovative, and I think that's a really important piece. The challenge we have at ASU right now is that the digital tools are not pervasive with all the faculty and are unfortunately not a tool yet. So we have three very strong faculty in digital design – Chris, and David, and Jason, all very different perspectives which is important. That is not a one way optic view of how we look at these tools. And so where the next step for the school would be that, well, just like AutoCAD or Rivet, Rhino is just another tool that we have, that we employ, but possibly use it in a way that's about optimizing these various conditions.

So, to your question, I think pedagogically we have some strategies coming up where we might be mixing faculty. We might take faculty who are less proficient with these digital technologies interface with those who are very proficient and have them teaching together with students so that the faculty are becoming more aware of these things. And I think that can be a win-win situation. So the goal for us, I think and personally believe, is that these digital technologies allow us to see differently and allow us to potentially create. As I said before, for me personally, it's about integration. How do we begin to use the tools to allow us to integrate things where in the past we might have a harder time doing that, if that makes any sense? I don't know if that answers your question completely yet, but I'm sure there are more questions.

Interviewer: And you mentioned that you've started the light studio.

Darren Petrucci: Yeah, three years ago. And the intention was that all the students coming to ASU either from our undergraduate or from outside would take the light studio and we would teach them digital tools with this program of light and then that would be something that they could do – but now they have those tools as part of their skillset as they move through the curriculum. And light was important because light is one thing that we in Arizona have. So, if you were to differentiate us from Columbia, not much light, but light is a very unique characteristic here. So how can we position that unique characteristic with a new set of tools or a contemporary set of ways of thinking and bring those things together?

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school, ASU? In some schools, they use for example information theory, general system theory, network theory in their pedagogy.

Darren Petrucci: Yeah. I would say right now it's interesting because we're probably not doing – well, my answer to your question would be that I think we should know all of those things, not just one of them. But right now we're doing it more in terms of a systems theory approach in ways of thinking about how multiple systems can be brought together through this technology. From an information technology standpoint, or a datascape, etc., I would say we have people who deal with some of those issues, but it's not a core pedagogical piece. I think I should differentiate between things that are core – [that] all students take – versus things that are elective, that are built upon the expertise of various faculty.

And so, I think we have faculty who can deal with information and other things, but we don't have that as part of the core pedagogy to it. Now I will tell you that I do believe that the next evaluation of the graduate program is focused around digital technologies. I mean, much more fully focused, not on the technologies themselves for the sake of technology, but that we – because the other piece of this that I think we're really missing animation. Animation is something that we do in pieces; we started bringing that in the curriculum. Alex Nino teaches an animation course, and we have tried in various locations. And this is based on a pedagogical notion that as designers we need to get into the fourth dimension, into time-based methods of representation and analysis, and so animations and video become new strategies for moving out of 2D drawings or even 3D models into something that talks about the life of a building and how it evolves through time and space, or the way we analyze the city or a document, the praxis of the city.

Interviewer: To add that fourth dimension.

Darren Petrucci: Yeah. That fourth dimension. So that's a piece, if you were to ask me, of a model – I would say the fourth dimension, which is also connected to something that's non-digital that we're looking at, which is storytelling as vehicle for synthesizing complexity, right? So if you imagine that – I think, it was the CEO of Harman Kardon – the speaker of that company said that, "Poets are the greatest systems thinkers, because a poem can take all the complexity of an idea and communicate it in the most succinct, simple way without losing the complexity." And so as designers, we are constantly challenged with synthesizing complexity, which is part of the mission of the school, but when we have to present that solution, we can't start with every bit of complexity; we have to start with an idea that covers all that complexity without losing it, does that make sense?

Interviewer: Yes.

Darren Petrucci: So I would say that pedagogically the systems thinking, the storytelling and time-based methods of representation are all connected as to where we think we can be going with this. It doesn't mean we will be dealing with information technologies or other types of topological consequence.

Interviewer: Then the general system theory is the way?

Darren Petrucci: Yeah. Because I think that's something [we] can pull together. The one thing that we all do in all of design disciplines – and, frankly, it's what connects us to engineering and to the school of sustainability – is systems thinking. And so, it's the ability for designers to think in terms of systems and the integration of those systems, because that's extensively what we do, or the synthesizing of those systems. And I think it's a question of what's the role of digital tools in that process. It's not about the digital tools, let's figure out what to do with them; here is how we want to think 'how can these tools benefit that thinking?'

And it's in the articulation and the identification of those systems, and that's where I think the digital tools come in, in the way in which we can input that data into a set of algorithms, for example, to begin to come up with something that helps us see things differently. Not that it's going to design it, but that it gives us something to critique in a way that might have taken us longer time to do in the past. I actually really believe that where we are nationally or internationally with digital tools is that it's inevitable that when you have a tool that allows you to do a thing you couldn't do in the past, people play with it quite a bit. And because the fabrication technologies haven't quite caught up to the modeling technologies, for example – and I know I'm speaking to a very particular part of digital technologies – but it resides a lot in ornamentation, right, because people can do ornamentation, and it's usually overtly complex things because they can make them. All right, so if I want to design something that is very complex, they are going into that with an a priori notion that they want complexity. All right, it doesn't mean that it's better designed, it doesn't mean that it's more synthesized, that it's a better synthesization, I should say, of that complexity. But what it means is that they know that they can create complexity with this tool, so they are going to do that, and I think that's what you are seeing happening.

But I think we're coming out of that a little bit, I think people are starting to realize that they're kind of playing with the tools and the aestheticization of these things can be a lot more sophisticated, for example, looking at typological conditions – Jason Griffiths' popular notion of suburbia, right. And so, looking at the single-family house and putting a set of algorithms together, they began to allow that typology to create types and variance. That's a different way of looking than just 'what kind of shape can I make with this thing?' or 'how can I make a cut sheet or something?' So it's a notion of what the digital tools are, in other words; do you create a culture slider in Grasshopper software? So that would be an interesting way of thinking about it. We can plug in all these other variables, but what's the culture signifier, what's the signifier slider, what's the algorithm for that? What data can you put in for that, and how does that affect them all? So that becomes pretty interesting.

Interviewer: So when you were talking about people using these fabrication machines to create the complex ornaments, it reminded me of Adolf Loos' article "Ornament and Crime."

Darren Petrucci: Yeah. Well, that's right. I mean, it's true.

Interviewer: But he was talking about the waste of human energy as labor – not about the use/power of a machine to do the job.

Darren Petrucci: Exactly. I think it's very true that these tools will allow us to bring more craft back into design, meaning that the architect now should be more in control. In the days of Loos, the craftsman would work with the architect to create these types of things. Craft is pretty much being taken out of the building industry. It's mostly products that we combine in different ways to make buildings. So the ability for us to – and, again, this is of course a more subjective approach to it. I'm less interested in the ornamentation of how these tools are used, although I think that it can be quite beautiful in some places, and I'm not against it. I'm not as severe as Loos, but I think that it's a little bit like using a sewing machine to cuff my pants as opposed to creating an entire software.

Interviewer: Instead of something different and innovative that serves a problem.

Darren Petrucci: Yeah. I mean, I think, you know – use the digital tools just for creating complex patterns and cut sheets and 3D models and things. I think, it looks complex, but it's actually not, do you understand what I mean? The complexity comes in with, as I was speaking to you before, the different variables that you are plugging into the equation that integrates those things; it might be that the solutions are actually quite simple, but you wouldn't be able to optimize that solution if you hadn't had the software ability to run through the types.

Interviewer: How are they integrated into your curriculum – I'm talking about the models/paradigms of digital technology that you've mentioned?

Darren Petrucci: So it's a good question. I think, you know, obviously that the studios are a primary place where these things can happen. I'll give you another example of digital tools. So one of the things that we use in the Ira A. Fulton School quite a bit is building stimulation software for the energy program. So Marlin Addison – who is actually one of the authors of eQUEST, which is what the Department of Engineering uses as their software from doing building performance analysis, HVAC systems, etc. – that's something that is taught in a class that supports the studio, and then the students use it in the studio as part of their arsenal of tools that they can deploy in designing the project. So the point I'm making is that if the students take electives in digital tools, like with David or Jason or someone else, that's a place in a curriculum where they're introduced to those things. . .

Filiz Ozel, who is on our faculty, is in a process right now of documenting all the digital tools that we use in all the disciplines in the school to create a digital curriculum in the school. Because, for example, there are programs that industrial design uses like SolidWorks or other things that we could be using in architecture, or we could be using in interior design. Visual communication design uses 3DMax; nobody else does. Why are we not doing that? Where [are] the redundancies? How do we begin to create a digital curriculum that allows our students from multiple disciplines to better cross over, right? So if you and I both know Revit software – and I'm an interior designer, and you are an architect – we can now collaborate in a more significant way. And so, I think, one of the goals with the digital tools is to – the great firms that are good on digitals tools, they're promiscuous with them. They don't care what the program is; they can use them all. I'll build it in this, I'll drop in that, I'll take it over to this, I don't care. Or I'll use this tool for this information technology piece, and I'll use this tool for something else – it doesn't matter, right? I'm not trying to use the same tool for both. But mapping that is really important for the school, because what it can allow us to do is create a curriculum within each discipline that recognizes that we're speaking a similar language when we started to collaborate because that's a big goal for us – is to start to collaborate.

Interviewer: Do the assignments in the studio enforce the idea of system theory?

Darren Petrucci: System theory, I would say not in our studios, but here is the irony of this: the word parametric is always thrown around with 3D modeling programs. Parametric is all we've been doing in architecture since the beginning of architecture, right? It's multiple matrices that we're bringing together. So in a comprehensive building studio, there is a systems approach to the way in which they look at the design, or the program and the conception of the design of a complex building, right? All of those systems that happen in architecture. Now the challenge is, what are the other systems that they are bringing in that are more contemporary to the day's issues that are not just about HVAC systems or structural systems or cladding systems, right? What are the social cultural systems that they are bringing in? What are the climatic conditions and systems they have deal with? And so those students are doing systems thinking, but they are not cognizant of the fact that they are doing systems thinking.

So the challenge is for them to move into a digital realm where they have to begin to identify those systems in a more robust way. It won't be hard for them to make that transition, but I think most architecture schools around the country are very poor at helping the students have a consciousness of what we're teaching them. Every architecture school in the country teaches systems thinking; they just might not call it that. They might not verbally understand there is a science/sign to systems thinking and that in some ways they are dealing with it, but they do not let the students know that they are systems thinkers.

Interviewer: I remember at Pratt Institute, in one of the studio projects, they asked the students to create a unit without telling them the next step. Then they had to multiply it to create an architectural structure from that unit, a system!

Darren Petrucci: Yeah, this what I call "mystery is mastery"; they trick them into making cool things because they are afraid that if they tell them what the next step is they'll go too fast in the process!

For example, in our first year now they take a similar approach to things through a form of abstraction and topography. I'm not necessarily convinced that this is the right way to go. The example that you bring up, from Pratt, is one way of system thinking, but that's a scalable approach to systems thinking . . . A kind of unit multiple or an aggregate situation is one approach to system's thinking, but that's a scalar approach to systems thinking, and that's sort of what Chris Lasch is interested in, right? I mean, it's this fractal set of nested hierarchy that creates something that comes with an a priori formal proposition that I'm going to make a brick and then I'm going to multiply that brick in a thousand ways and that's going to result in a space – or I'm going to blow the thing up really big.

Interviewer: And thinking about detailed connection.

Darren Petrucci: Right, and I think that again . . . is a kind of theoretical construct to guess who understands a certain sets of skills. So in that case probably the biggest skillset is understanding the relationship of the part to the whole.

I think that's a systemic approach, but I don't think that's systems thinking. Systems thinking is when you have a set of multiple variables they are looking at diachronically.

So, for example, we teach systems thinking in the school a priori , and we call that. We have what we call the eight design imperatives in the architecture program, [which include] 1) history, 2) program, 3) context, 4) technology, 5) construction, 6) and representation – and we say it's in every single project in every series asset, the minimum deal with all those pieces. Now some of them might deal with construction technology more than others, or program with that, but they have to be responsible for them. So you can't run a studio where I'm looking at that metal box and then turning that into architecture without doing any case studies or without understanding contextual thinking; you have to deal with all of those pieces. It could be that the context for that metal box is the world of metal boxes, and we have to look at those, understand what that is, but it's designed to allow for the curriculum to repeat itself in every studio without repeating the content.

. . . Students recognize that those six things are independent systems, and . . . I might, if I'm beginning a project and I'm going to design an architecture building shell from a historical stand point – so if I take that line of thinking, I might start looking at the history of architecture buildings. I want to know what was the first architecture building, what are the most contemporary architecture buildings, what architecture buildings are built in climates like this, wherever it might be, and I take that approach to understanding that. The next system might be the site – where is it going to be built, what are all the site conditions that I've got to deal with? – so what's the system that is relative to the site? The next condition might be the program of the architecture building – what are the technologies, the construction, the representation, how am I drawing it, am I conceiving of this thing in plan and in section? So what happens is you pull the systems across diachronically and you get these synchronic moments, where they begin to align, and we get the alignments. That's when you have synthesis.

So the question for me with digital tools is: How can they better do that, help you better do that, because that's what we do? . . . So with your example of two blocks and the connection between them, [are] you talking about the mode of production or how it's going to be assembled? . . . Make the joint thin or whatever you want, but maybe these are concrete blocks. So we can put as one of the variables in the system, in the digital tool, the constraints of concrete: how thin can I make it, what's the PSI of it, what's the compressive strength of it? You can put that in the algorithm. So when I start making blocks and connecting them, if this becomes too thin of a connection, it will tell me, or it will allow me to make it there. That's the integrated systems thinking model. That's what I'm talking about. . .

Interviewer: It's systems thinking.

Darren Petrucci: Yeah. Absolutely. I mean, the entire world is systems thinking; you have to look at it in sophisticated ways as architects. We teach it; like I said, every student, everybody trained as an architect is a systems thinker. I mean, if you've graduated or if you've successfully completed the course work, you are a systems thinker; you just don't know it. And you know the mission of our school, I don't know if you've seen it, but it's "tomorrow's designers will shape collaborations, synthesize complexity, and catalyze transformation for public good." The synthesize complexity is the systems thinking piece.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

Darren Petrucci: The eight design imperatives relative to the systems thinking – and this is not digital tools, but that's been for the last seven years since I've been the director – we implemented that when I started. The light studio and the parametric thinking for the last four years . . . The other thing we did from a digital tool standpoint is five years ago we had to teach an undergraduate construction course. So we conceived of this construction course based on Revit software. So we thought, 'Let's have the students take construction documents of famous houses from around the world. Let's have them build from those documents, the 3D model. They build everything. Don't build it in a way you'd do construction documents; build it in a way that all the insulation is modeled, the footings are modeled, everything is modeled.' So when the student is constructing from the blueprint, they also see where the connections are and things.

They're using the visual tool as a visualization technique to see the construction of the building because so many times – you and I are probably trained [that] we do a wall section, we think we know what we're drawing, and so you see it three-dimensionally – you don't really understand. So that's been in place for about five years, and that's a curricular piece that's been very beneficial because all of our students now from the undergraduate to graduate know Revit very well. And so we teach them construction, but we use that as a tool; it's not about learning Revit. In fact, we probably don't use Revit the right way because we're not interested in forming a wall rivet. I can make that wall a composite wall as a line; it will show drywall and wood framing and stucco, right? But it's not a composite wall in the model; it's just a mass. So we want the students to actually draw the framing, model the framing, model the drywall, model the stucco on the outside. . .

Interviewer: What do you think are the positive and negative implications of these things?

Darren Petrucci: Well . . . if I showed you books that come out of other architectural programs from around the country . . . and all the work looks exactly the same, meaning that there are all these formal complex design strategies, but structurally they don't work . . . I mean, even the book size, the cover of the book, everything about it; these are two very different schools . . .

Interviewer: Do you think they have the same argument with Russian and German old schools? They were designing buildings that the technology of that time was unable to build, but it's more about experimenting.

Darren Petrucci: Yes. Well, I mean, obviously, that's what school is about: experimentation. And I'm a big fan of experimentation . . . If you ask me what's the danger of that, in my opinion, the danger is we moved to fashion. We moved to a place where . . . the intellectual rigor of the architecture could get lost in favor of what's the coolest looking building I can make, and at that point you have to wonder 'what's that going to do to the profession?' and if it's purely about statistics, so to speak . . .

Interviewer: Looks cool but there is no depth or critical thinking.

Darren Petrucci: . . . It's just illustrating stuff . . . and what they are doing is they are affecting the formal language of architecture because practitioners from around the world come to these schools, and they see what the students are doing, and then they go back out and they try to make them. That's one of the great things about architecture schools is that they influenced practitioners all the time, because they were looking for new forms of ways of thinking and working. When the practitioners go out and do it, they have to legitimatize it.

. . . I mean, it's all about the gesture. There is a place for that, but I'm afraid that's not what we should be teaching the students, that it's just about the gesture, because now they can make gestures that are pretty sophisticated, [but] what's the content of that gesture? . . .

I think it's important that we don't cheapen the power of these tools by just making them illustrative, if that makes sense. So that's a negative. The positive is you know they are very powerful tools that can help us integrate things – because I think fundamentally good design does more than one thing, if you just look at the definition of design it – this stupid water bottle holds water, but it's something that fits in my hand, it's something that can be packed easily, the ribs are designed because it's so thin to give a structure, you know, thinnest plastic you can possibly make. You can grip it; these grips give a structural capacity and give you something to hold, right? So that's an optimization of a material to a program to a use. That's what we should be doing in design . . .

. . . It's not a Frank Lloyd Wright era anymore; programs are way too complex – the forces we have to deal with, the communities, everything we have to deal with – and the complexity today is a hundred times more than it was years ago. You can't do it on your own, so the digital tools can help you in a couple of ways. One way [is] they can help you collaborate. I mean, everything from the internet to the way we can collaborate over distances to teamwork – which is a function on say ArchiCAD where I can have one model and you and I can both be working on the same model simultaneously – to how we can instantly make things and send them back and forth.

Visualization [is] phenomenal for increasing the amount of collaboration we can do . . . This is the place where digital tools could come in that hasn't really been worked out for design yet. Imagine that all the students in the studio had a dashboard [similar to the set-up in video games like World of Warcraft], and they're working on something. Say part of my dashboard is the climatic response, part of the dashboard is my structural analysis, part of the dashboard is my program, part of the dashboard are my three other friends that I'm working with, part of the dashboard is a connection to technological projects around the country or around the world . . . But this notion that digital tools can give us exponential learning is a really powerful idea.

. . . But now imagine ten of us are doing a building simultaneously – that's a powerful idea; that's how it works in the real world. Nobody individually does the building anymore. So imagine in the studio you have the digital tools that can allow you to all work on the project collaboratively. When we teach our comprehensive buildings studios, students work in teams of three, where all three of those students can work on the same computer model or take their pieces and work simultaneously; they could make decisions in real time, like all the World of Warcraft. If you can make decisions in real time, it's not like the old days where, if I was the architect I would do the plans, I'd give it to the structural engineer, I'd wait two weeks, they come back to me with plans, their grid didn't match my grid, then I'd fix that, with the client we change something, it goes back to you, then the HV [makes] decisions, you know. We can have one model, all look at it in one meeting, and change the ductwork that will parametrically change the size of the beams, that will parametrically change the side, and see what the implications are – very powerful . . .

Interviewer: How do you believe technological models shaped architectural pedagogy historically?

Darren Petrucci: Very significantly. Technology is a huge part of what we do as architects. In the beginning of architecture the definition of the architect [was] the master builder. The technologies [at] that time were that they were building; so the architect knew how to build, and they would understand the technologies that allow us to lift a stone to a place right or put two things together. When we moved from that to a much more synthetic role of representing the things they could put into place, obviously drawing as a technology was the way that we did that . . . Actually, models were made before drawings, and then drawings, and then drawings and models.

. . . It's remarkable to me that we still print blueprints . . . iPads and things are starting to help where the technology allows us to visualize the entire product three-dimensionally on site in place. For example, you can use augmented reality right now with your iPad and the geo-spatial thing, put your 3D sketch-up model into the program, walk out to the jobsite, hold it up in front of the jobsite, and move it and see the building, right? . . . So one place that I think it's improved is our ability to visualize three-dimensionally all the complexity of the building on site moving in a mobile way.

The second thing that I think that it's done is obviously allowed us to work in more collaborative ways with contractors and architects and consultants. The Revit and 3D BIM modeling took off because HVAC guys were using it. Because the ductwork was so complex, they were making 3D models of it. Contractors realized that they didn't know how to do that – so the HVAC guys were running their project – so they became sophisticated and then they started using 3D modeling. Architects, frankly, were slow to come up behind to learn it. So what happens, I think, [is] whoever owns the model owns the design, so you don't want the contract or to build the model. And you want to be—

And when Frank Gehry did the Disney Hall, they gave him the CATIA (Computer-Aided Three-Dimensional Interactive Application) drawings, but they rebuilt the whole thing in Revit because the CATIA drawings didn't show the steel members exactly the way they were – didn't show all the pieces, and so they built every single system. And then the contractors actually were talking about they had to put like RFID tags on the steel members so that with GPS they could hold them up with a crane in space and hold it there so the next one came in to touch it. The building is not about static; you know, they built it from the top down in some ways. So representing the building three-dimensionally, the ability to work in teams and then, of course, [use] the things that we've been talking about, which allow us to hopefully integrate these systems in more optimized way. I think those are three ways off the top my head that I would say it's influencing architects in contemporary ways of working, and it will continue to do [so]. And, you know, we'll, very soon we will no longer make drawings. And if we build models correctly, we'll send the model to a factory. It will make all the pieces, they'll come out, and the contractor will just work on assembling it.

Interviewer: Are we still using the same methods of designing – for example, hand sketches, sketch models – or did the rise of computer use change the way we do and think about design?

Darren Petrucci: . . . I still sketch a lot to get the conceptual pieces . . . I can actually sketch on the computer. So the translation from your brain to your hand is always going to be there, and always, I think, important . . . The one thing we still do in this country is we build in a very primitive way; our technological tools are representing things which are much more sophisticated than when we build things. In Japan, they are starting to look at full-scale prototyping so that it literally prints the building with the machine onsite, and that's inevitably where we're going . . . So our ability with these digital tools is to imagine those things and actually do the structural engineering. So I think, to a point, it has increased our imaginative possibilities for realization, and it has sped up the time to do things.

I think the misnomer with clients and with most people is that digital tools allow us to design faster – not true. They allow us to make changes faster, but it doesn't mean you can design faster. I mean, Frank Gehry probably – arguably the most advanced digital firm in the world – builds hundreds of models by hand before they get into what they are doing because it's in that process of ripping something and having a happy accident of gluing something incorrectly, or of being able to pick it up and do this to it. We still can't do that digitally, and that's one of the challenges, frankly, with design – the happy accidents . . .

Interviewer: Do you believe this relationship will evolve over the next ten to fifteen years?

Darren Petrucci: I think it's inevitable, right? The tools aren't going to go away . . . We are just going to get better and better at them . . . The question will be: how do the digital tools allow us to actually deal with the performance of these buildings so that esthetically, performative, programmatically, all these things, they are optimized? . . .

Interviewer: Which technologies or technological paradigms do you think will be the most influential in the coming years?

Darren Petrucci: I think certainly visualization is the most influential, just because as a designer the more ways which you can see something, the better [the] design will be. So that's why we draw and build models and do things: because as many different ways we can represent the project, the better the design will be. So I think visualization is always going to be at the forefront of a lot of these things. The second I would say has to do with the collaborative component of it. I think that's actually going to be the next big influential piece. The third will probably be the algorithms and the ability for us to actually, as designers, write algorithms. We're going to move from opening up a Revit model, picking a window, to actually writing a script for the window, right? Because this is the problem; it's like a LEGO kids toy. I don't care what you make as far as it looks like LEGOs. In LEGOs, I can only pick this window, or [I've] got to pick this thing, and that's what Revit is. It's like a big LEGO machine, so there are in fact a finite number of things you can do with it. We have to move beyond that. We have to get to a point where we as designers are writing the codes for these things because the design is going to be in the algorithm; that's where the design is going to be.

Interviewer: What are the major/key issues that you see arise from that?

Darren Petrucci: So I would say that one of the key issues is that we are not victims of the tool; we actually become authors of the tool. It's of course true that when we drew by pencil or ink, we were limited by what the ink or the pencil could do, right? But we will always be limited to some degree about what we can do. But if the pencil only drew straight lines, then that's a limiting factor. I think our ability to be more influential in the tool [is] in the development of the tool. So when Naval architects had to design boats, they didn't have curves; the straight line can't do that, so they developed the shift curves which we all had as architects because they were designed for Naval entity. They – we could buy the curves, well, that has maybe ten curves you could buy, so what [are] you going to do if your curve isn't the right [one], right? So why are we not designing the curves? So I think that the digital tools will allow us to do more of that, but I still think that certainly, from an educational standpoint, we are not teaching the students how to write algorithms; we're teaching the students how to use the tools that are existing out there. So as a default we are just going out there, and that's why I think Frank Gehry's office still works in models because they can make things three-dimensionally by hand that they can't write the algorithm for. So then they'll scan the thing, and then building it

[is] great. So it's a work-around, and I think we will always be innovative enough to be able to do that. My fear is when we move completely digitally, which we will inevitably.

But Architecture has bigger issues than digital tools. I mean, the role of architecture in United States, the role of the architect in the U.S., is a much bigger problem than the tools we're using. Our position in society – the impact or the importance of buildings in the landscape – is far less [important] in [the] United States than it is in Europe or Asia and other places. The part for architecture that could be devastating is if the contractors and engineers are starting to actually have more sophisticated tools. For example, Morgenson, when they as a construction company built a digital model of the Frank Gehry building, they connected it to a schedule. So now when the thing is animating, the schedule is moving. So I can see the groundwork, the site work, that's happening, how long it's taken. So now we've got two different systems that are in the model – the architects didn't build the schedule into it – so what's happening is the contractors' model is much more sophisticated than the architects' model. Or, in the case of engineers, where if you take Arups' The Advanced Geometry Unit (AGU), they are using robots and other programs that are much more sophisticated than anything we can do. So they are controlling the design development or the project because they're saying structurally it has to do this, and nobody else is arguing with them because we don't know how to run that program, right!

. . . Do we have to become more sophisticated with how we are going to engage those things? Are we asking the engineers the right questions? I think that's the bigger issue for us, not just all the form[s] that we can make; it's really understanding the processes, the modes of production of how buildings are made and being influential in every step in the way. Otherwise we're going to lose control of it, and that's dangerous.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools:

How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

Darren Petrucci: One, I think it's changing the way that students work collaboratively across disciplines. One of the things that is changing is plagiarism . . . That's a significant unintended consequence of the digital tools – that I could download a 3D building fully formed model from three different places and cut and paste and put together and make a new building out of it. You know, we couldn't do that in the past; nobody could do that in the past . . . I mean, it certainly could lead to a whole bunch of Frankenstein architecture, but it could also begs the question of what is intellectual property of digital tools and designs. Here is an example: Bill Massey. Back in the '90s when he designed the first puzzle joint…

Well, patented all those. Well everybody uses the puzzle joint now. Does he collect those royalties? No, of course not. It's a design pattern. It's not very enforceable. But you start wondering if somebody starts developing certain technologies digitally, are those going to, just like music, be downloaded for free everywhere, and what's our IP on that? If I downloaded – you know, as an architect, my construction documents are my property. They are not even the client's property; they are my property so you can't just take my plans and build another building. Well, if there is a 3D computer model of the building and you get access to it, you could just build it. I can't even control how many sets of drawings were there. So I think that's a pretty interesting side effect that's going to start affecting things in the future. Or if you work in a big office like Gensler or Arups or something, you work in a part of a building, and you develop certain piece. Could you sell that piece to somebody; could you take it with you when you leave the office and start your own firm? You know, everything becomes a lot more. It's like Napster; it totally changed [the] music industry if you think about it. So it could totally change IP in architecture or a copyright.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Darren Petrucci: I was asked to [judge] a thesis prize for their students . . . three years ago. Not one model, not one physical model [was presented] – everything was two-dimensional drawings, 3D models, but [there was] not one physical 3D model of any of the students, which I found remarkable. [Students] are not using all of their tools available to visualize the project to really understand everything about it. They're just – because they're so [focused on] the 3D visualization of it that they have everything they need for it, they have never built a model of it . . . – or in other cases, the model's 3D printed, and it's the final model but it's not 10 models along the way.

So I think in that case it's influenced students' ability to think about iterations. And the irony of it is innovative design process is the most important process. You don't just design it once. You design it, you get critic, you change it, design it, you change it, you design and change. Digital tools are the most forgiving in terms of the ability to save something in a certain moment and archive it, but they don't do that either; they just keep remaking the model, remaking the model, remaking the model, and all the steps along the road where they're making key decisions are just lost. I think that's a problem. I think that's something we can easily remedy because the tools allow that to happen. But I would say that it influences our ability to have iterations along the way visible and physical. When I was in school, we built models, we made [one model after] another model. They don't do that anymore because they can so easily change the existing model. Why would I save the old one? I'll just change it.

Interviewer: In our last meeting, Darren, you mentioned that the American architect Richard Meier conducted a long-distance studio at MIT. Will you tell me a bit more about that?

Darren Petrucci: He conducted a studio at MIT . . . They would show the work with cameras so he could critique it and give them feedback and things like that. So I was at

Berkley not too long ago, and there was a review going on. And it was funny; there were three people sitting in the studio, and there were three podiums with laptops open, and people were Skyping as reviewer. So there were virtual reviewers at the review, which I thought was very weird, but interesting and a way for people to just participate and review work from across the world. That's a pretty exciting thing to do because we couldn't do that in the past. I still think it's important to have people there – not just Skype people – but it's hard to see body language and all the other complexity that comes with the review process, all the other non-verbal communicative things . . .

I mean, the way education is going, the model of having fifteen students in a studio is a luxury – huge luxury, one professor with fifteen students. If you were in Italy, it's a hundred students, and they work at home, and they bring their work, and they get critiqued, and they go home. It's very expensive space that we have here . . . so I could definitely foresee a future where there are many more students in the studio and many more professors that are virtually connected to it. It's probably inevitable, unfortunately.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Darren Petrucci: I think I talked a little bit about that. I think I talked about collaborate models and how these things can help. So is there anything else do you think that question needs?

Interviewer: Right. Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Darren Petrucci: Well, we talked about the negative and positive, I think, in some degree.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Darren Petrucci: In the studio? Well, it's, as I said, I think where it should go is more toward iterative design process's ability to integrate various systems without losing, and frankly, even if I'm not physically making the model with my hands, I'm printing iterations of the model or I'm digitally cutting iterations of the model that I can use and look at. I mean, the irony of this is that the speed at which I can make things is much faster [with] laser cutters and 3D printers. But I'm not using them innovatively, right? It's completely inversely proportional, and the days when I was in school, we have to build a physical model, cut things on our main lines with a razor blade, and glue things together, right? Exacto knife – and we would glue them together; we would make a model. Well, I can do that so much faster now, even with a higher level of complexity.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Darren Petrucci: Probably not, probably not as much as we could or should. I think that their awareness – you know, Marshall McLuhan said the medium is the message, in fact – how aware are they that the tools are driving what they are doing or they're driving the tool? I think they get that to some degree, but I don't think we openly critique them until it's in their final review. But in part of the process, I don't know that we do that. I know we do a lot of things. Like I'll do it to students – I'll say you need to animate your project, and I don't want to just see a walkthrough; I want to understand simultaneously. The reason that they animate is to show two things happening at the same time, but I won't give them the technology and say, 'go find one and make it work.' And we just leave it to their own devices, and they are pretty good, pretty fast also. They'll just pick it up and learn it and use it.

Interviewer: Some students, they only – they master a tool/a program without the critical thinking [of] why they are using it.

Darren Petrucci: . . . Certainly in beginning design studios, you need a lot of constraints because innovation will happen with more constrains. If you can do anything you want, you won't innovate. But if I tell you to design [a] building where everything has to be orthogonal – you give them a polemic exactly, and then they begin to innovate because they realize the limitations of it and they have to now go beyond the limitations. And that's probably true with the digital tools, if they were taught that way. If we said, 'We're just going to do this tool in the program, and you're going to build the project in just that tool,' that might actually be an interesting way to look at it, where they have to really see the limits of that tool.

Interviewer: And do you teach students to push back on and innovate beyond these paradigms? How so?

Darren Petrucci: We try. It's always a challenge. It depends; this has to be predicated with at what level is the student. If they are graduate student in their final year, absolutely they need to be thinking transformatively. The way I talk about transformation versus innovation is innovation is something [that] happens incrementally over time. So if I said to you, 'design me a better water bottle,' you're going to go out and look at the history of water bottles. You're going to understand my hand; you're going to understand drinking, liquids, all those things, and you're going to make a bottle that's little bit better than this bottle. That's an innovation. If I said *transform* – if I ask you transformatively, I wouldn't tell you to design a water bottle. I'd say, 'Why do we drink?' You have to ask the question. You can start it with designing a water bottle; that's a beginning design project. At advanced levels, you have to ask a question; you don't begin with the brief. So the question is: why do we drink? Well, now, I've got to understand biology. I've got to understand what liquid does for my body, and I might not come up with a design solution as a water bottle. It might be something that's in my ear that goes in and connects to something else. I mean, who knows what it is. It might be clothing that saturates my body and might pull up something completely different. They realize that this is not the solution to dehydration. The solution of dehydration is to keep the water in your body . . . So that's the difference, and at the upper levels, you want people to think transformatively. At the lower levels, you want them to think innovatively. [Innovation] is about the individual; transformation is about their collective and the team because you need a team to ask a question of why do we drink?

Interviewer: When you attend a jury, do you see students that critically engaged these paradigms in his/her work?

Darren Petrucci: Yeah. It's a good question. My gut is not as much as we use to . . . I had a professor at Harvard, Mohsen Mostafavi . . . [who] said to one of the students, "You have every drawing except the one you need." What he's saying is that you've done the plans and the sections and the elevations, but you haven't done the drawing that communicates the concept of the project.

So I think what these tools allow us to do is actually make drawings that we couldn't make in the past so easily . . . We're in a recession, so representation is a big deal right now because we're not building a lot. And in the '70s and the '80s – you know, when there was a lot of representational paper architecture – the montage – there was a whole culture of the way you presented work. I think we've lost some of that right now because I think all students do is they just cut a section of building in the computer model and they say, 'there is my section. So I think it's really lazy, and the technologies have created a kind of amazing apathy toward – You know at the Beaux Arts it was the analytic as a drawing. You would have the plan unfolded, elevations on the sides, the detail right, and then it was a composition . . .

Interviewer: On social responsibility, do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Darren Petrucci: Social contract, it's a good question . . . I think you have a social responsibility, one to the public. You have a social responsibility to people other than just a client. I think it's important because extensively everything we do is in the public realm. Even if it's a private house, it's part of the earth; it's part of that ecosystem . . . So that's a new variable that comes in as I'm looking at solar orientation and other things that would be a piece where digital tools could help with the social contract. I think the ability for the tools [is] to also communicate to the laypeople the significance or the performance of the building.

[With] the digital tools [there] is this notion that I can monitor the performance of a building. You know, we have dashboards all over the campus now, and you can actually . . . see how much energy every building is using on the campus. Or if that's public access, then that's a social responsibility of you as an architect to produce a building that's not sucking up all the energy of the campus. So the tools of digital information technology allow me to see those things more. Victor Hugo said, "This will destroy that," and he was talking about how the book destroyed architecture because, prior to the invention of the book, we use to read buildings. The buildings were the ways in which we communicated to society, the story of the culture [was] entablatures; Greek architecture is all about telling stories.

When the book came out, it destroyed the building because all of that was now in the book. So the buildings didn't have to communicate with the people anymore, because the Bible could, or other things could. So, you know, church is a good example pre-Bible; you go in your church to read the story of Christ or whatever it is on the church, but then when Bibles were printed, everybody could have a Bible. I don't need to read it on the church anymore. So the question of how will the digital technologies replace the signifiers of the buildings, or the performance, or the program of the buildings, whatever it might be – I think that's something we have to think about.

Interviewer: How might this definition of social responsibility evolve in the future in relation to technological advancements?

Darren Petrucci: . . . I think, safety – like life safety – is a very big issue. Digital tools are helping us model ways in which people exit a building. Part of the social contract is that if there is a fire in the building, how do we get out? Arups and others can model where smoke is moving and actually show how people should move through the buildings. So there are all kinds of incredible complexities of ways in which these tools can help us have a better living world and have more social equity in the world. I think it's a really good question because none of these tools are . . . engaging . . . with this bigger idea.

Interviewer: Also limiting the waste, in material and construction—

Darren Petrucci: Exactly. That's another way, it's another way that specifically digital fabrication can help us . . . Testing, examining, experimenting are the performative part of it; that's the simulation . . .

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Darren Petrucci: It's pretty low right now. I'd say there are three.

Interviewer: What are the primary factors that you believe may hold back those faculty members who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

Darren Petrucci: I don't expect any of the other faculty to actually be proficient in using the digital tools. It's more about their awareness in what the tools can do because the students can learn the tools, and it's sorta like if I know what a mayline can do, I can instruct you on how to make a drawing. I don't have to actually use the mayline. So I think we're going to probably go through another generation before everyone is much more adept, but you know the technology is changing all the time, so someone will in fact always be behind on the technology. It's more important with the faculty having awareness and understanding of the technology than ability, always.

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation?

Darren Petrucci: Yes. All the time.

Interviewer: What are the opportunities these technologies offer? What is lost by their use?

Darren Petrucci: I think I've covered that. I think it has to do with integrating things like that.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Darren Petrucci: I'll talk about two things with that. One we haven't talked about this, but I think economics is something that should be part of the algorithm; it's – one of the things that designs schools don't do a good job of teaching students is cost. So in every single project in these two books I showed you there is obviously a complete assumption that cost is not an issue. It doesn't matter, you know what I mean? You need to think about how it might be built, but that building could cost a billion dollars if we were to make it. As I said, they haven't thought about the mode to product or a unit multiple or how it's made. I know this isn't your question, but I think it is important that we talk about [it], which is one of the things these tools could do as we're designing something like that. Like Rivet, ArchCAD, and AutoCAD doing [this] in more conventional way is [to] have a cost calculator built into it. It's never been an issue for us, the cost. In fact, we just spend half a million dollars on new machines downstairs, and we buy new software we need; for us it's just the price of doing business.

Interviewer: Do questions from the profession impact the way your schools has adopted and/or implemented advanced technology in the design studio?

Darren Petrucci: No, the opposite – we're ahead of the professions.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Darren Petrucci: . . . We believe it's part of [our] mission in the school's public good that – how are we using these tools to, let's say, deal with our climatic conditions? So there is not a single student here in the architecture program that if they're doing a project in Phoenix, orientation is not an issue; they have to know that. They have to understand the lack of rain; they have to understand the extreme heat; they have to understand the heat island, and they do. And so the question is how are the digital tools helping inform the design of those things? That's an ethical question.

Interviewer: Was it an ethical reason for you to buy these tools to prepare the future architects and designers?

Darren Petrucci: Yeah . . . Firms that are established are hiring students, and the students change the firm. So if students weren't coming out with advanced skills in these things, they're not going to be marketable to the firms, but also we're not going to affect the firms. We're not going to affect what's going on with them constantly changing. Now some firms like Morphosis or Foster, or any of these guys, you know, they are ahead of the curve because most firms are not at all using the Rhino yet, or if they are they're very pedestrian-wise or aren't cutting things in digital fabrication yet. There are students who know how to do that, so it inevitably shifts that firm.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Darren Petrucci: I think we covered that in some ways. But, if I'm going to sum it up, I guess, it's a question of if these tools allow us to see things differently, how are we using them to see more, not just different? If they allow us to work faster through iterations, why are we not making more iterations? And if they allow us to connect and communicate with each other in more powerful ways, why are we not collaborating more? Those would be the three main things, I would say.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Darren Petrucci: No, I think the only question would be this notion that the technologies obviously move much faster than the pedagogical models. And so, inevitably even if we picked up the latest and greatest version of this and that, by the time we started teaching, there would be a newer version of it, or there will be a whole new program out there allow[ing] us to do something else. So I think we have to accept the fact that we want to increase the amount of experimentation that we can do in the studios and use as many tools as we can use to do that through the filter of what is contemporary. What are the forces of contemporary designs like I talked about before – time base, representational techniques, synthesizing the incredible complexities that we deal [with] today, and collaboration? But I think we have to recognize that we have to constantly be changing. We can't get comfortable.

You can't set up a digital curriculum and say that's it, right? So to that point, you can never build and should not build a curriculum around a tool. You have to build it around a curricular set of ideas and then use the tools you need because the tools change and there will be a better version of this or something else; you have to be promiscuous with the tools. You have to just treat them all like it's a razor or in a pencil or a straightedge, and that's it . . .
so I would never design a project around Rhino. I would never want the faculty to say, "We're going to push the Rhino software to the limit." That makes no sense to me.

Interviewer: How about pushing the fabrication technology limits that you have at the school?

Darren Petrucci: Makes no sense to me. I think [about] using the fabrication machine as a tool that allows us to take a design idea and make it, yes, because good things that are made are going to use the smartest tool and the dumbest tool in the shop. You're going to use a hammer, and you're going to use Five-Axis router, like CNC; but you need both of those things. So the key thing for me is that the digital technologies are not seeding the pedagogical agenda. There are pieces that enable an advanced pedagogical agenda to take place. So I would say that, in the 21st century, architecture education should increase the amount of complexity because the tools allow us to do that. They should increase the mode of production and the iterations because the tools allow us to do that. They should increase the collaboration because the tools allow us to do that.

Interviewer: Well, in my literature review section when I looked at the German and Russian schools, I found that they had and hold a deep philosophical and theoretical [premise] behind using technology, the reasoning.

Darren Petrucci: Yes, that's right. If you don't have that, then it's all just technology. And not to say people aren't looking at the technology and what can I do with it, but it's going to be a good for a week, you know? The example I typically give is in energy design. Thermodynamics haven't changed in the history of the world. Heat still transfers in certain ways. The law of thermodynamics that energy can either be created or destroyed still holds; gravity still works, right? What has changed is our ability to design a building and simulate the entire building from an energy perspective on my laptop. I couldn't do that ten years ago. I couldn't do that 20 years ago, but I can do it now. That's the difference, the difference between the Russians and the Germans and these other guys that had a theory on the other piece of the technology. Today we're doing the same things because they haven't changed. We still have a lot to learn from biology. But our tools now can have us doing things that we couldn't do as easily and as quickly as we could do in the past.

The Sydney Opera House was as formally complex of buildings [as] you are going to make. They built it. They did not have AutoCAD; it's all hand drawings. Antoni Gaudi's Sagrada Familia, the church was all done by hanging weights upside down . . . you know what I mean? So those laws haven't changed. Eladio Dieste's Church, Atlantida Church, with the curving brick walls, you know, they built before they had any of these things, in 1952. So I'm not a believer that these are allowing us to conceive of new structures that we couldn't have conceived or built before. I don't believe that. I think what they are right now is just fashion; 'let's make cool things.' I mean, for the most part, with the really good ones coming, is how has that completely changed the special relationships between programs and city? How has that allowed me to reconceptualize the role of our building in an urban context? How has that allowed me to reconceptualize my body in the space? How can I see that quickly and test the lighting and test all the pieces in a way that I could have never done until it was built historically?

It's the visualization, it's the ability to see differently, it's the ability to work faster through iterations and things – that's what's changed . . . The technologies are allowing us to build these things that we couldn't build in the past. It's allowing us to see things differently, but I'm not convinced yet that it's fully changed our imaginative process yet.

Interviewer: Thank you so much.

Darren Petrucci: Yeah. You're welcome. Good luck with it.

3) David Gersten

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school (Cooper Union)?

David Gersten: . . . I think we are in a time of enormous transformation, obviously, and to the point where it's not even clear if it's a paradigm shift or multiple paradigm shifts – they're all colliding. Every aspect of life is in transformation: social, political, economic, biological, technological, of course . . . With regard to the question of computation – the question of mathematical interpretations of the world, all these things – is in some way the impact it has on our world. And what I mean is that there are some instruments – if you think of instrumentality, you think of tools, you think of anything from a chisel to a table saw – what you realize, you can think of them as hovering in between us and the world. Every instrument in some way speaks to the body and speaks to the world outside. Think of an external geography. So a table saw, the teeth on the blade, they have been cut; their language, their syntax is speaking to the wood. But the height of the [table] is speaking to my body. You don't want a ten-foot high table. So we have the physiognomy of the body, the spirit, and thought and all that, memory. And that thing is in between. It's addressing me and the world . . .

I'm just building up to what I want to say about the computers. You know, if you've chiseled wood, you have a chisel, and you have a mallet, and we all know that you don't chisel wood with a hammer . . . And you have to start to think – your body starts to wonder why. Why don't you [chisel wood with a hammer]? OK, well because you'll hit your hand. But what does that mean? It's fascinating. You have a chisel, and you have a mallet. A mallet's large. Why is the mallet large? Some people say it's because it softens the blow and all these kinds of things. What's really going on is that our embodied knowledge of that experience, right, what's happening is that there's a double impact. This has to hit there. But our mental attention can't be there; our mental attention has to be there. If you use a hammer, you have to watch, so you hit like this, and it's a very disturbing experience. And basically you're trying to aim, and you hit your thumb, alright? Mallet allows peripheral vision. So now we can unlock our mental attention from a location, transfer it to another location, and our peripheral vision can do that, and we embody the experience of that situation. So the instruments create a kind of embodied experience.

I often use the violin as a perfect example of that. We can't talk our way into playing the violin . . . We can even make a violin in a shop, physically make one; we know we're not going on stage. Why? Because of the very particular situation of playing the violin – because our body has to learn it . . . You sit in a room for 15 hours a day with a bow and a string, and then your elbow knows it, your wrists, your lungs, your ears . . . There's a spectrum of instruments between us and the world we're navigating. Ok, so, if we think of computation . . . I would say there are a *few* instruments in a spectrum that have a unique position in a sense that not only are they hovering between ourselves and the world, like a chisel or like a table saw, but they're also becoming part of the actual fiber of what we would think of as out there, meaning the external geography to a large extent is now interwoven with a few instruments.

I would offer capital, financial instruments and computation – mathematical interpretations of the world – as two examples where you can no longer say it's only between us and the world . . . Currency is a mediator, but it's also a part of the external flow. It's part of, in fact, space and time. Space, our spatial temporal experience of the world, is not only mediated or navigated by computation, but it is to a large extent constructed by it. That's why we know these things change everything. I was on a panel a month or two ago with a friend of mine named Frank Wilson who's a neurologist, and he wrote a beautiful book called *The Hand* . . . Basically one of his propositions is that the brain grew out of the hand when our forearms were no longer load-bearing; basically, our hands lost their full-time job. Because they had been busy, all the time keeping us up, all of a sudden now they're here. And they had all this ability, and they had nothing to do, and they started causing trouble, alright. They started grabbing stuff, pulling, poking, making questions, making problems, things that the body had to solve . . . And his argument is that it's the problems that the hands caused that caused that brain to try to keep up . . . Frank and I got into a fascinating discussion about medicine and computation and the images of the body, the body and its images, and architecture and its images, and what we understand about the relationship between them . . . [Frank's] whole argument was that there's a crisis in the works that had to do with a very kind of, ya know, these unpredictable things that come out of computation.

. . . A new crisis is developing with the body and its image, and the crisis is fascinating to me. It speaks to really a question of architecture. It is that the location, the spatial location of the battle to save the life is no longer happening with the body. It's happening in another room with the high res MRI images, right? You know, all the imaging in medicine – hospitals are now massively technological. And so an unpredicted thing has resulted, which is the doctor and the patient's relationship has dramatically changed on both sides. Of course, the doctor is still trying to save their life – fighting, battling, heroic, you know, anything possible . . . but the work is happening in an imaging room so the patient is not there. The body, them. And what's happening is that it's breaking down the emotive relationship between doctor and patient . . .

Now think about that, talk about mediation, talk about computation being between us and the world, bringing us closer, taking us further. Like Skype, things bringing us closer, and things take us further. So there is this whole issue of empathy and ethics . . . Where's the battle to try to get an architecture that embodies our humanity, an architecture that is a manifestation of what it means to be human? . . . One of the things I was trying to say is that I think it's fair to say my primary interest, to be honest, in computation at all is the impact it has on our spatial-temporal experience, long before we start, you know, sitting at some computer to design something.

. . . I think the reality of the tsunami of transformation we're in has to do with the massive pulsations of space and time that computations are bringing in a thousand ways . . . I reject in architecture curriculum, teaching, the whole "it's just another tool" thing . . . It's obviously not just another tool . . .

I think there are plenty of reasons that we should basically all be like this, looking as close as we can at what's happening, the transformations that are happening . . . Does the creation of architecture, which is a place we're going to be, does the creation of that within a mathematical interpretation of the world (computation) – does that presuppose that the world itself can fit within a mathematical interpretation of itself? . . . Are we saying that we can make the decisions, the language, the interpretation, the syntax, the whole thing – that the site of operation of those questions is a mathematical interpretation? . . .

Interviewer: Well, I read about Cooper Union [that] they're anti-CAD as far as technology or technological paradigms in their school.

David Gersten: Well, that's what I was saying . . . Drawing is an absolutely unique form of mediation and exchange with the world. And by that I mean with pencils and paper. You can make all kinds of images, you know, with a computer. All of that, it's fantastic; it's all a very particular thing. It is not drawing, as I would define drawing . . .

I teach a course called A Material Imagination of the Social Contract, and it is 15 lectures that map out what I'm just hinting at right now. And material imagination has to do with that. We articulate through a kind of intimacy of listening to and speaking to the world through substance, and what we're making is space. So, you can't remove the substance and think you're still doing that . . . I wrote a piece called "Figure Figure" once, about the figure of the body and the figure number. Like number figure, incredible things relative to how numbers create numbers. And Oppenheimer. That's why I wrote about Oppenheimer because basically the birth was with him, with the Manhattan Project. And that I think is a massively powerful thing that has had an enormous impact on the world. So my interest, as I said, in computation is the external geography; the field that we work in is built to a large extent out of computation. Now at Cooper, so we believe in drawing and making and writing and reading, and computation is part of that, but it can't erase the others.

Interviewer: For example, some schools with their technological paradigms, they adopt information theory, the way they teach it. Some are enforcing systems theory where the units create the whole, or it's more important than the whole. So which models/paradigms of digital technology are informing design pedagogy at your school?

David Gersten: Our school is such a diversity of voices . . . I'm a maximalist; I believe in spectrum of means of engagement . . . Let's say you have a 160-person orchestra, maybe you have, I don't know, 40 to 50 different kinds of instruments on a stage, Carnegie Hall . . . I believe that the synthesizer has a rightful position at the stage at Carnegie Hall with the other 160 musicians . . . Now the synthesizer also has an ability to mimetically imitate all the other instruments. So, with the synthesizer, you can turn it to violin, and you hit the key, and it makes violin. So it can mimetically reenact every other instrument that's on the stage. Now, in . . . architecture education and in the profession as well, what I think has happened is that the synthesizer showed up on the stage, and it said, "I can do all of you, so get out. You're not needed anymore because, not only can I do you, I can do you better than you. And I can iterate you, and I can save copies of you." So, we don't need the spectrum; we don't need all those instruments. It burned out the stage, and for me, that's a tragedy for humanity.

. . . To say, "Get out!" to charcoal on paper, plaster, concrete, steel, glass, metal, bronze, clay, ink on mylar. All of them – it's just like the string section, the wind section, the percussion – we need them all. And I don't believe anyone would argue that it would be better with – in music, if we just got rid of all this stuff because the synthesizer remembers it all, and you can fit it all in a little thing. . .

So I have no problem having computation at the table. I have a problem when it tells everybody else to go home . . . And it has and it does to a large extent. So, does that mean I'm against technology? Of course not. Do people want to say it does? Of course they do. . .

Interviewer: So what kinds of assignments do you give your students in your studios?

David Gersten: I run a first year studio, and we invent the problem every time . . . And for a number of years, I would have the students draw full-scale drawings of the tools . . . Then I had them turn them on, use the tool, put wood in the saw. How do you draw that? Full scale. I mean I always say if they can build it out of metal, you can build it out of graphite . . . Then I have them, with the body, draw the choreography because between the body, the tool, and the material there's a certain dance that goes on, right? . . .

I started working with boats. We started working with buoyancy and displacement . . . Architectonics of buoyancy, we did that for a while . . . And then I gave them a series of drawing assignments; all that had to do with some of the things I was saying about the violin, but with the drawing . . . If this is the parallel edge, and then I grab a triangle, and then I grab the scale, as I move the triangle, the triangle moves me. My hand is in a choreography between that and the parallel edge and the scale . . . We do a week, 10 days of that, it leads to a whole kind of thing in the room – bodies moving, filming themselves, making plans, which gets very interesting.

We then clear a space in the middle, like a public space in the studio. And the first year we did it we built a wall, just a line. Here's the room, we put a line, and we started to project the first two weeks, a time delay . . . So what happens is it starts catching up with itself. So you start to see the wall being built, and then you see the wall inside the wall.

Then you start to inhabit that, and it becomes a question . . . Rather than sit at some monitor and watch Grasshopper do something, I want the body to be in the question of the world and its images and how do you navigate that. So we then do all kinds of things you can imagine – absorb all the desks into the – because the desks are all in the film. So you're here in the room; there's an image of you there in there. There's an image of you here which is different because the camera was at a different distance; you start to draw that . . . You start to see images because whatever mark you draw is filmed, and that becomes a film mark as well as a drawn marker. And that is really interesting. So the site in some way is impacted. Of course we're using film, we're using technology, we're using computers to push it all through, all that. But more it's how can the space we're in become a site to ask these questions?

Interviewer: Also in the first project you asked them to draw life scale, or real scale, of the technology they have. Full scale.

David Gersten: Full scale's one of the most interesting scales. Well, because, think about it: scale is about distance . . . I think this is related to computation in a huge way because I ultimately think – and this gets into sort of neurological traffic issues. I do work with brain scientists and a lot of different kind of people. I have filmmakers, and photographers, and astronomers, and neurologists, and philosophers, and anthropologists – I bring them all into everything I'm doing . . . So in a strange way, scale and perspective are linked . . . But scale is a kind of spectrum of distances that we can determine we want to establish with the world, and we have to really know them, just like the violin. You can't have a visual understanding only; you have to embody the scale changes. So, full scale is fascinating because immediately here you are. So to draw something at full scale sets up an amazing thing, where it's still representational but it's substance and substance aligned. There is no distancing between the substance of the drawing and the substance that you're drawing. It's a cut.

Interviewer: And that's like the – you were clear about the disadvantage, but there's no positive about the technological paradigm that some schools are using?

David Gersten: . . . I think that computation has its own mysterious way, and it's as mysterious as mathematics itself. It's a profound mystery. And I'm interested in getting at that. So the instrumental efficiencies that it brings – obviously, everybody knows that . . . Which is to say this drawing is something that if you spilt coffee on it, you'll really cry. If you spill coffee on your plot, you just go plot again . . . And I think when I go to Barcelona Pavilion, it makes me laugh with joy. I burst out in joy. I am moved . . . I think that's a human connection, a spectrum of humanity that is manifest into space. And I think it's essential.

So, again, I'm not saying the computer wipes that away. We have to keep our eyes open. All of a sudden you spill a coffee on a drawing, and you don't have to redraw it; you start treating drawings differently. You start treating coffee differently.

Interviewer: I remember also a student once, for one of her projects, a virus came into her laptop and deleted all of her work. And she was crying, and so they have also that. But how do you believe technological models shape architectural pedagogy historically?

David Gersten: Well it's been a long history, obviously. And, years ago I tinkered with a piece called the Headless Horseman. The idea was if we were going to understand the real role and impact . . . of computation on architecture, we may get there if we remove the monitor. Because I thought that the monitor was essentially a distraction. It made us believe it's about images. It made us think it's all about what we're looking at, watching happen. Of course this goes back to the Greek theater; it goes back to pre-Greek theater and all the way up through Hamlet. The reenactment, pre-Greek, the reenactments of myth didn't have any viewers. There was no one watching. Everybody was a participant; everybody was a teller; everybody was a listener, so there was no audience . . . Greek theater introduced separation between actor and audience, and participation at that point was viewing and listening. You're still a participant, but you were watching. Now a very interesting thing happened as a result of that; that's directly linked to computation.

Here's a stage. The hills and meadows behind the stage became part of the play because perspectively that folds up. So the reenactment is happening here, and that story is co-mingling with the world behind. So here it is, and it's – now that's often the people's – where they lived. It was their village. So then when they left and they reenter, they're entering the story. Brilliant because that's how myth could guide life, because you were entering and living in the stories that were being reenacted. At a certain point they realized the possibility of scenery. You could put vertical walls because that's verticalizing. You could put vertical walls; you could paint them, and they became mimetic fragments of the landscape behind. They were mimetically imitating what was behind them. Why? It's obvious why – to control the story. You could make it rain if it was sunny out. The set, the scenery – you could start to articulate a story that wasn't necessarily happening out there and inhabit it. Now you can take that technology and zoom it forward and very quickly realize the monitor – it's a fragment, a mimetic interpretation of what's beyond that we can control. We can make it rain when it's sunny. We can Facebook, Skype people.

So, why is that important? Because there is a profound technology that is linked to stories, to theatricality, to all that, and also linked to control. Alberto Perez-Gomez is a dear friend of mine, and he writes about this beautifully, that basically the birth of Western art, architecture, science, and technology is in that moment, is in this recognition that if we mimetically imitate the world beyond, we can control it. Now what ends up happening is what? We end up living in [a] completely encased world that we can control. One that denies the world beyond. Meaning, again what I said about iterations . . .

But, the point is, if you take that scenery and you bring that to the Globe Theater – Hamlet and Shakespeare – and then you bring it all [the] way forward, you eventually get the World Wide Web. You get this mathematical interpretation that we can control. An issue is, of course, now look at the ruptures, look at global warming . . . And we essentially respond to the double; we essentially act with it . . . to our detriment, to our peril, because the world's still out there, the cosmos is still out there, the night sky is still out there . . .

You know, I had a conversation with Kevin Kelly – his argument essentially is that, yes, technology basically brings as many problems as it does good, and he's a huge technologist. He wrote a book called *Out of Control*, and it's very famous . . . For him, technology and ideas are the same thing, and that if you have good ideas, you have bad ideas . . . And he sees technology as the same as ideas, so more technology will eclipse the problems that it's creating because of this little swerve.

Interviewer: So this is what you believe, Professor, I mean, more technology is a bad idea, or it was just a—

David Gersten: . . . I don't think a rational person could say that the spectrum of the questions of the human condition at this moment can be solved by technology alone. I think you have to be kind of delusional to think that. It requires spectrum, and that doesn't mean that more technology is bad at all.

. . . I do a lot of work on financing, finance, I think about finance, I write about it, for a lot of reasons. Almost the same thing I'm saying about technology: I think financial instruments are one of those instruments that are no longer just another tool . . . At RISD, I teach 16 departments of MFA and design and architecture. I have glassmakers, and photographers, and painters, and architects, and industrial designers and landscape architects, all of them together – big seminar. And a good six weeks of it is on hardcore financial instruments, and I'll go into trading and debt equity, compound interest, and all this. So, Risk Distribution: Why I Teach Algorithmic Trading in an Art School, what that means is I think that the genes phase of capital and technology is increasingly constructing a globe double that we of course couldn't go back, shouldn't go back . . . The trajectory is not inevitable, and trying to imagine a future that amplifies the spectrum of the human condition – I'm ultimately interested in ethics. Ultimately I'm interested in ethics, and to me ethics has to do with amplifying the spectrum of the human condition, not diminishing it.

Amartya Sen, the great economist, Indian, Nobel Prize – the aspiration of collective judgment should be the amplification of individual agency. Collective action should amplify individual agency. In my view, the creative imagination and how we can amplify that and manifest it into the world is essential – that's the project. How we go about doing that is as mysterious today as it was in 1880. Nobody knows what's going on. The idea that material – that the physical world is somehow part of the past is absurd, and it's a very prevalent one. It's an idea we hear all the time. So if you make things, you're considered nostalgic. Think of the absurdity of that. I'm made of substance. I'm the mysterious condition of being a body and having a body . . . I take possession of my body with language so I'm a mix of substance and language as is anything that we make if we make it beautiful, if we make it well . . . So where [do] I think things are going? I think they're going into an incredibly fascinating time . . . I think it's going to be much more complex, even in the technology side, much more complex by all kinds of computational situations; we all know that.

. . . So, I teach in art school because I believe that the dominant forces of our time – finance and technology – they need what the people in the art school know . . . I want to make sure that people know how to listen to the world. I teach another course called Listening Critique with 16 departments of ours. People who know how to listen to the world also understand computation, mathematical interpretation, finance, all those things . . .

Interviewer: When we talk about the historical schools, this is also that missing – the Bauhaus, V in Russia, the Soviet Union, they enforce technology for design architects, and the architect or designer is knowledgeable [about] how to visualize technological artifacts to make it more human. First, you said about the monitor – you said to replace it with something, said the monitor is—

. . . But that's why I called it the Headless Horseman. You take its head away, what do we do? Now we have computation without the visual as our dominant relationship to it. What happens? . . . Michael Benson, he's an astronomical photographer, a great filmmaker too, and I had him come to Cooper . . . I had him giving a talk and – incredible, like Hubble image type stuff – and a student said, "Oh, what satellite was that taken from?" and he said, "Oh well, that was actually taken from Hawaii." [The student] said, "But don't you have to be in outer space to take that picture?" And he said, "Where do you think we are? We're in outer space." He was quoting Buckminster Fuller, by the way, which he immediately said.

. . . The hardest part is the necessary. Where's the voice of that, meaning how do we even sort that out? Technology does not give us the questions or the tools or the framework within which to ask what's necessary. That's human; that's ethics. It prefigures technology.

Interviewer: But wasn't the reason of creating technologies to solve a problem of the necessary?

David Gersten: . . . I think the future is by far more complex and interesting than a new code. I think currency itself is going to transform beyond what we can imagine . . . Have you ever heard of Bitcoin? . . . It's a computational currency that's completely independent of any authority. It has no country backing it up. It has no central bank. It has nothing. And it's now in the hundreds of millions of dollars, if you converted it, of exchange on the Internet . . . So that's just one little hint . . . But I said that because with all of these things in flux – the myopia that somehow the next software is the future – becomes really rather obviously silly.

Interviewer: How are digital technologies and their associated paradigms changing the social structure and culture of the architecture-design studio? Some schools, the technological paradigms they're using are changing the structure of their studio.

David Gersten: Not in my studio. I would say in others, but not in mine.

Interviewer: So in some schools, if they follow the information theory or the systems theory – so they teach the students of creating units in the first year without telling them why they're doing what they're doing, then make it more complex – that entity or that unit they create, it creates another unit to interlock with, so it's creating a system. It's multiplying that system, different scale, number. They create a structure. Network theory, as well, [there] was a professor who even organized his class based on network theories. It's just like one of the technological paradigms that some of the schools are adopting.

David Gersten: I'm actually extremely interested in networks and including computational networks. I think the real territory to be developed in that [is] interaction among different forms of knowledge . . . And it has to do with the idea that when things come into proximity with each other, they interact, and when they interact, they transform. Darwin. And I believe that that evolution – of course, knowledge evolves, which is to say if we can bring into proximity diverse forms of knowledge, I called that Disciplinary Geography. You have a kind of geography. Think of the Greek theater, think of the pre-Greek, think of reenactment of different forms of knowledge. Bring them into proximity, and they transform; they're polymorphic. I think disciplines are polymorphic. I think knowledge is polymorphic, which is to say it grows differently in different environments or contexts. Its very structure does, not just its content. And so I work pretty intensely on this notion of network in the sense that there's an interdependency that creates a new form of knowledge, including embodied knowledge, abstract knowledge, mathematical knowledge, all of it.

Interviewer: Technological—

David Gersten: Technological, all of it. And I think in some way that's one of the great gifts of what we call technology is it allows for a very dynamic set of interactions of diverse forms of knowledge, and that I think [that] is a great area to develop because literally proximities are changing. Distances are changing.

Interviewer: Some schools say they want to teach everything to their students. They want to teach them programming, scripting. They want to teach them design. They want to teach them how to use electronic devices and how to build a microchip with the nanotechnology or nanoarchitecture. Basically there's no way for one soul to be able to master all of this. They have the knowledge of something, so that's why it's open for multidisciplinary—

David Gersten: Did you say for one soul?

Interviewer: For one person.

David Gersten: No, that's good. I prefer that, soul. Absolutely, but that's why the notion of proximity matters because, again, I think there's about a five decade debate about interdisciplinary – I think one of the misunderstandings is that somehow it melts or diffuses any of the disciplines. In my view, when I bring people together – I bring a philosopher, a neurologist, an anthropologist, a photographer together – I don't ask them to leave their discipline at the door; I want them to be the neurologist. But, let's all sit at this big table and make something happen, and that I think is fascinating.

Interviewer: Also there's an argument about students using technological paradigms. All the technology that we have today, they're not using it critically; they're not challenging the technology that they have in hand. Do you think there's a way of changing that?

David Gersten: . . . Everything I'm talking about is the way of changing that, which is to say to open up the conversation beyond the "for and against," beyond all the laziness of "it's just another tool." Those things are not going to help anybody. What helps is to try and sort out and map out some sense of the vast transformation of our epoch. And, I'm always for difference rather than sameness . . .

So I want to restore calm. It domesticates the situation, and I think at any moment in the last thousands of years, it's the recognition of just how undomesticated a situation is that leads to an eclipse, leads to a turn. So, I think the point is to develop conversations that don't diminish, but amplify difference. And that will lead to people not superficially using these things.

Interviewer: In the design studio, for example—

David Gersten: . . . You have to be willing to withstand the spiritual and mental and creative risk, you have to aspire to be precise, and you have to be honest about what's your question . . . If you can be honest about that, try to articulate it, even if it's not in words, then stuff starts happening . . . That's all I try to do, I try to get people in a situation where they know they can take risks, they know they can be honest, and they try to be precise. Beyond that, I really don't have any interest in or business telling anybody what they should do . . . And the more people we can get doing that, the more we can amplify our humanity, the spectrum of what we are – not diminish the spectrum, but increase the spectrum.

Interviewer: I did my undergrad also in a traditional architecture school. Everything was manual even until the thesis, everything by hand. Not because the philosophy was to teach us that way – because the professors, they weren't knowledgeable of what's going on in technology or what's happening in other schools. But now I see students start their sketch concept in a software program. I don't know how they do it. There is no way for me to start the design without doing

sketch models and drawings, and then maybe I'll use technology just to test it more or to take my design into it. Even we talked about Grasshopper and stuff. They show the Grasshopper definition on their sheets and give them to the jury to look at – missing the scale, I don't know if I consider there's depth in it.

David Gersten: Well I've often said that architecture and humanity face the same predicament, and I mean the discipline and us are in an interesting moment together because both of us are material and both of us are literate; we're substance and thought. And so both of us are in transformation now relative to this issue of computation and image and body and its images, architecture and its images.

Interviewer: Also, social responsibility in the students, do you think the technological paradigms that we're in, that we're using, are creating a new social responsibility? What are they, and how can we teach them to the student?

David Gersten: . . . For me, the great beyond, the final frontier is ethics. It prefigures epistemology. It's at the depth of the ontological questions, questions of being, and epistemological questions, questions of knowledge; we need them. And the two of them together create a kind of buoyancy. They keep us afloat a bit. We know where we are, but they don't give us direction, and in my view, navigating, knowing which way to take that is ethics. It prefigures them both. Richard Kearney, a great writer, wrote a book called *The Wake of Imagination*, and he beautifully articulates this whole problem of ethics prefiguring knowledge . . .

. . . We create thought and questions and content, and so I think education is a place of freedom within which is a profound social activity going on. So ya, of course, with all these transformations the schools themselves become increasingly important, not because what they're teaching people to know how to do [work] later, because they're a place to ask questions, like you're doing. To ask these questions, that's a contribution, that's a social contribution.

Interviewer: For the future architects or designers to go out there without – we don't have a social cure – they're responsible for changing things and adding things. There's also an issue of some faculty that don't want to adopt these new technological paradigms.

David Gersten: They shouldn't if they don't want to. If they want to, they should.

Interviewer: There's a percentage at Cooper Union, do you think it's more toward people or more adapted to technology?

David Gersten: Everybody chooses their own way, I don't know a percentage. Funny, I describe what I did with the students, the film, so am I adopting the new technologies or not? It's hard to say.
Interviewer: Well even if you're questioning it, I think you're adapting it. But you

can see it from the projects from the designer, it will reflect the professor's way of teaching.

David Gersten: I would say at Cooper each individual has taken a position. Cooper's not a light place. Everybody has a position on everything. So if having a stance with regards to all of these I would say we're at 100%. How many people are using computers in their studio, I have no idea.

Interviewer: Do you think there's an economic reason for some schools to adopt technological paradigms whether there's—

David Gersten: Of course! There's the quick money . . . There's all kinds of ways of making money out of that. Not the silly software company stuff, but the branding. Presenting themselves as cutting-edge, high tech, that's—

Interviewer: So they're willing to invest in buying expensive—

David Gersten: Of course, because they want to look like they're part of the game . . .

Interviewer: Do you think ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

David Gersten: Ya. Cooper can't help itself; it's an ethical project. Peter Cooper founded it. It's a free school, 150 years, no tuition. You get an incredible – talk about disciplinary geography – get an incredible human geography because of that. I have students in the first year who have done PhDs, first year undergraduate, and I have students from the projects. And that mix you can't beat. And so it's an ethical project, the school is. And so everything we encounter—

Interviewer: So about the future now, Professor, what do you think are the most pressing questions and issues regarding the relationship between architecture or education and advanced technologies and the design studio environment?

David Gersten: . . . Years ago we had a new president come to Cooper, 12 years. He was a technology guy, and everybody was nervous. And he was saying things that make people nervous like, "Aren't you outdated? Don't you think that maybe . . . ?" And I was acting dean at the time, and I brought him to our end of the year exhibition . . . So we're in a room twice the size of this, charcoal drawings, ink on mylar drawings, computer drawings, steel work, bronze work, concrete pours, wood, maybe twenty materials, glass, stained glass, people working on everything in this room. Incredible. And he looked around and he said to me, "Oh, but couldn't you just do this all in a computer?"

So I took him over to the window at Cooper in the lobby, and I said, "Look, let me show you something." I said, "This is concrete, wood, glass, and there's paint. Four materials in a little square this big." I said, "If we're going to ask them to do that, don't you think this is how we should ask?" So to me, the pressing issue is how do we get out of the myopic vision that segregates, the segregation of the material imagination? . . .

A lot of schools don't have shops anymore. They don't build with materials; they don't do any of that spectrum; they do it all in the monitor. So I'm against that like I'm against any other segregation . . . So, the pressing issue is how do we get to the mental, and spiritual, and social, and ethical clarity that ends that segregation, and is comfortable with that full spectrum of making, including computation. That's what architecture's got to figure out . . . So for me a pressing issue is to craft the intellectual framework within which people can start to invite back everything they threw out. That's not going backwards; that's going forwards. Part of building that intellectual framework is making that point. You can't date wood or glass or steel or concrete or brick or earth or body . . .

Interviewer: You mentioned hand—

David Gersten: The absurdity that somehow this can become dated . . . I think it's going to get better. And when I say better I simply mean spectrum, the inclusion of how we engage with the world.

Interviewer: Is there any issue that I have not brought that you believe is important or imperative to understand the implications of these technologies and the relationship to architecture education?

David Gersten: The body . . . is also one of the ways that will help us navigate these questions, meaning the problems of consciousness, of the limited surfaces with which we meet the world and how we apprehend and construct all of our experience through them, all of this enigma. Architecture is equal to us in a sense. I have often said that it's the other half of us. It completes us . . . To manifest the widest spectrum of what it is to be human into our spaces and to listen to those spaces as something that are completing us is really the kind of big project. And in a way that becomes a kind of framework within we can ask the kind of questions you're asking. So to what extent do they do that or not? That becomes the kind of mental, spiritual environment within which we approach the problem. That's all I can probably add at the end.

Interviewer: Well, thank you, professor, for your time. Great help, thank you.

David Gersten: Of course. I enjoyed it.

4) David Jason Gerber

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school (University of Southern California)?

David Jason Gerber: Well, the answer is yes.

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school?

David Jason Gerber: Well, I don't know what you mean by models or paradigms.

Interviewer: For example, a general system theory, information theory, network theory – some schools hold a mix of models or paradigms.

David Jason Gerber: Well, I think at this school, there is not a holistic approach, so it would be inaccurate to claim that we follow a systems theory model, for example. I think, frankly, the model is ad hoc, and it's actually highly dependent on the individual who is instructing, at what level they're instructing, and what's required at that particular level of instruction. What I mean by that is in the B.Arch, Bachelor of Architecture, the NAAB-accredited B.Arch is one thing versus the post-professional degree, which is another, and the models are very different. So, you are dealing with a school of 700-plus students like many of your other schools on the list. So, I don't think there is a top-down model or paradigm that we can discuss in that fashion. I would say that individuals are informing the pedagogy at the school, and then there are some top-down aspects that are informing, which are more to do with professional practice and building information modeling, for example, and a strong desire to bring more and more digital technology. But, again, a lot of it is ad hoc, I would say.

Interviewer: Is there a specific theory, theoretical framework, that guides the way you teach architecture?

David Jason Gerber: Are you asking as an individual or at the institutional level?

Interviewer: Institutional level, first.

David Jason Gerber: I can't really speak for the institutional level in that sense. Again, I don't think there is one guiding model, one guiding paradigm, one guiding theory. The faculty here is generationally very diverse, and I would say theoretically diverse, culturally diverse. So, diversity is something that makes it hard to answer that question as a sole paradigm, a sole model, a sole theory.

Interviewer: On the individual level?

David Jason Gerber: On my level? That's a really interesting question. I haven't really thought about it, so I like the question. I think of the world through – I use the terms loosely, like non-academically validated – but systems theory and biology, or theories of evolution in that sense. I see the world through computation, and I'm not just saying that that's a theory in itself. But that's how I see the world, and that's how I develop my curriculums.

Interviewer: Biomimicry design?

David Jason Gerber: I don't want to use the term biomimicry per se, but I do refer to people like Charles Darwin and Richard Dawkins very often in terms of how I think about the use of computing to solve design problems or evolve design problems.

Interviewer: You've mentioned earlier that the architecture school at USC Davis is heading toward technology, the use of technologies. How are they integrated into the curriculum?

David Jason Gerber: Well again, USC has a long history, which I'm not an expert in, but there are some very famous instructors and professors from this school that go all the way back to mid-century modern. And mid-century modern was about technology and material, even though they were not using a computer per se, and there are people like Ralph Knowles, who was famous for doing solar design, again without computers, but very much about technology and design. So, there is a long track record at USC that precedes the digital, which has to do with technology just like the earlier schools that you are studying and mentioning. But, then, to try to answer in the contemporary setting, I think there is no longer a studio, which doesn't involve the use of digital techniques and tools.

Interviewer: In all levels, undergraduate and graduate?

David Jason Gerber: Yeah, I think even from freshmen intro studios now there is introduction of the use of Rhino, so – but, the use of the Rhino software to actually arrive at the learning objectives, which in that case is composition and drawing. So, I don't think you'll see drafting tables anymore in the school. As far as I can tell, I don't teach freshmen studio, so – Drafting tables in my book are technologies just to be clear.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

David Jason Gerber: I will speak as individual. I became digital in roughly '96, okay? So, for me, my entire career has evolved from pre-digital use of technology to digital, and so that's a continuation and a continual re-informing of my own curriculums through digital means. So that goes back to about '96. As far as the school, I can't really speak for the school. I don't feel that, you know, it's being imposed on me by administrators or students, per se. I'd bring that to my classes in particular.

Interviewer: What do you think are the positive and negative implications of this?

David Jason Gerber: That's a whole PhD thesis in itself. At the core of what I believe to be a positive of the use of computation for pedagogical goals is, I always like to say, the computer is stupid. And you as a designer need to be able to control your tools whether it's the pencil or the mouse or the algorithm. And so the positive is it really requires rigor if you want good results. Another positive is computation enables more rapid design iteration. At the end of the day, that's really what designers want is to see, options, and to ruminate on options more quickly.

The negative implications? I don't really have so many things to say negatively. I think there is discussion quite often about the disassociation of the eye to the hand in terms of drawing; then I think there is something truthfully to be said about that. However, I don't really place a lot of weight in that conversation. I tend to think that, you know, people can see through the mouse and draw through the mouse; however, I am biased. And then I spent a lot of time drawing with the pencil in my own education, but I don't draw with the pencil anymore, so.

I think the implications – again, this is a conversation that could go on for hours – but the implications for the professional practice are clear. The market needs digitally savvy, digitally capable, digitally rigorous people. And without that, the professional practice of architecture will continue to erode in terms of its actual control over projects. We will be reduced to drawing pretty pictures as opposed to controlling the designing project. So, I think from my pole on that spectrum of discussion, the digital tools are really about enhancing one's ability to control the content of the idea. The negative implications are, you know, you have to spend more time in the curriculum teaching software, which is problematic because we really want to be focused on ideas. However, the use of the software enables us to get further than we would have in the past.

Interviewer: How do you believe technological models shaped the critical thinking in architectural pedagogy historically?

David Jason Gerber: I think all pedagogy is shaped by technology, I think culture is shaped by technology. I studied anthropology before I studied architecture – and our cultural content and our output. So, I don't think you can disassociate technology from pedagogy and from critical thinking. I'm not a Martin Heidegger expert, but maybe you are.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? How?

David Jason Gerber: Yes, and the how part is more rapidly and more rapidly and more rapidly. I do research specifically on your topic, but I do it through survey-based data gathering and some statistical analysis. And I have some papers coming out on this particular topic. And it's clear that the academy is behind the needs of practice, and if the academy wants to stay in the position of delivering quality individuals to the built environment, the industries, or on the built environment, we will need to evolve quickly. And I think it's going to become imperative even more so.

Interviewer: Do you see that future involvement is more toward the software development, for example, new software that will be developed specifically for the architectural pedagogy?

David Jason Gerber: Again I'm not the best person in the sense that I have a strong bias because most of my research is funded by [the] software industry. So, for me ,it's obvious they are paying attention to us and they are helping us. Yeah, the software industry wants us to be more involved, but there are lots of university reasons that make it difficult – but that's not part of your thesis; that's more accounting. But, yeah, I think it's clear that they are in fact supporting education. Look at the software companies that give away their software for free, and you realize in fact they've figured out that it's better for them if they give it to us for free and allow us to teach it more easily.

Interviewer: I read that NAAB will ask all architecture schools to adopt BIM system, Building Information Modeling?

David Jason Gerber: Yeah, well my research will suggest that people are starting to become much more aware, and there is also [an] understanding [of] the limitations and the hurdles for adopting BIM into curriculum. I almost don't think BIM is an issue anymore; from where I sit, it's automatic. BIM as a concept is being taught for sure, technologies in the school that are BIM technologies or VDC, which is Virtual Design and Construction technologies are taught. I teach those as well as some others. If we don't teach those technologies, our students are not very relevant in [the] industry. BIM is not a research topic as far as I'm concerned; it's just a factor of standards.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

David Jason Gerber: I think it's the era of the algorithm, to be honest with you. I think students of design can get away with not being algorithmic if they have an interest in design, which is simple, but if you have an interest in design, which includes complexity as in complexity theory, then it's the era of algorithm.

Interviewer: What are the major/key issues that you see arising?

David Jason Gerber: From the standpoint of pedagogy and curriculum, it's room in the curriculum to teach the skill sets. So, one of the papers I have in progress is the distinction between teaching skills as in software versus problems from where I sit, which is the ability to put into the curriculum, the content, which is really the science content so that the future designers are not just software savvy, but they are savvy about what makes the software do what they want it to do. So, I think the issue really is room in curriculum and how we define what's important in terms of computational designers or designers that are computationally interested.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools:

How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

David Jason Gerber: Well, the amount of space that we give to a student is shrinking, I think. I mean, I'm not exactly sure because I don't sit in the studio in that sense as a student anymore, but there is more open source and sharing, I would argue, because it's easier to share than handing somebody your model or a drawing. I think that's probably the most important thing from that question is that there is potential to foster a sharing culture, collaborative culture, through, you know, sharing digital material and content.

Interviewer: As a professor who was, maybe, taught in a traditional architectural school, what do you see different today in the design studio?

David Jason Gerber: The quantity of output has increased from when I did my projects by hand up there, you know, 20 years ago. The quality of projects – that's a little bit of an overstatement – the potential for a higher quality graphic content is obvious, the shift from 2D thinking to 3D thinking is a positive change, or even 4D thinking. The ability to harness, manage and then harness complexity whether it's geometric, whether it's cultural, whether it's performative is a great leap forward. The social structures – I think, group work is always group work in a studio setting; it's a challenge but, in many ways it's much easier than it used to be just as delivering buildings is much easier than it used to be because we have digital coordination.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

David Jason Gerber: I think all of these are made more easy. Team-based design, hierarchical organizations, I don't know what that really means in a studio setting. It's a flat thing; it's a studio instructor's students. Agile organizations, I know what those words mean, but I don't know what you mean, per se. Are they ad hoc? Do they change?

Interviewer: That they can change their role and adopt a new one.

David Jason Gerber: They can, but do you normally do that? No, you only have 15 weeks to teach the studio. You set up a team, and there is a group task; they do it. So, I think the technology has vastly made that easier, but it also doesn't alleviate lots of the social dynamic issues between human beings in terms of working as teams that they don't necessarily want to be a part of.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

David Jason Gerber: These positively affect peer interaction because, again, you have a more rapid ability to see each other's work: PowerPoint, PDFs, digital projection – I mean trends.

A silly trend is we probably will be moving more and more towards digital presentations, less and less paper. I don't think I see a clear trend in terms of group versus individual learning, though. Again, it is easier to have some group projects, but that has more to do with the culture of the pedagogy. I have been part of both cultures, individual work and group work; group work is definitely enabled by technology.

Interviewer: Do you use blogs to interact with the students? Post some tutorials and discussions?

David Jason Gerber: Yes, and I have implemented technologies at this school, which nobody else in the world has. So, yes, I use everything from the off-the-shelf Blackboard to some custom interfaces and some pretty new technologies in the 3D design space that are web-based.

Interviewer: You said no one in the world is using it? Why?

David Jason Gerber: Because we are the best – no, because I know the innovators and introduced it here before anybody else has been able to.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

David Jason Gerber: Yes, but I'm a design technology architecture and engineering professor. So, when you are asking critically engage, do I ask them to think about it in a history and theory setting? No, I'm asking them to critically engage within the context of solving design problems, so there is a limitation there. Do I ask them to understand rigorously what they are actually doing with their tools? Yes. Do they always do that? No. You know it's one thing to copy/paste a Grasshopper script or definition and use it to get some geometric effect, but do they always actually take the time to understand what it's exactly doing, which is what I would ask them to do? No, but I always do ask them.

Interviewer: How do you ask them, in assignment or when critiquing their work?

David Jason Gerber: It's the way I critique, the way they generate a problem. So, I look at, I try to impose on the design studio a research rigor, which is you ask a question [and] you answer a question, you pose a problem or you invent a problem, and then you try to solve the problem. Architecture is highly synthetic, and so you have to in some ways synthesize what your voice is about. We don't want to teach people to accept the status quo; we want to teach students to critically engage and question the status quo, including the technology they are using.

. . . Mastery over a tool, and I believe in craft and digital craft. But if you want to achieve a digital craft, you have to get under the hood and break it down. And so in that vein I ask for a critical engagement. I'm not really bringing to the table in my studios or in my seminars, which are much more technology laden, you know, Hegel, Einstein, or Benjamin. I'm hoping that it's covered somewhere else.

Interviewer: Do you teach students to push back on and innovate beyond these paradigms? How so?

David Jason Gerber: Of course. By what I just said, which is, you know, you don't want to just take things off the shelf unless you have good reason that the off the shelf is solving the problem that you yourself set up. So, again, my approaches to design studios, typically advanced design studios, are how do you manage and harness complexity for a reason, which is architectural content? So, yes. I mean, I am asking my students to invent tools, but I'm asking them to invent tools to support their own vision.

Interviewer: So, there is reasoning. The why?

David Jason Gerber: Yeah. I mean a computer requires reasoning, right?

Interviewer: Do students think critically about how these technologies affect architectural representation? Do you see that in their work?

David Jason Gerber: Not enough. I see too many commercial style renderings without any understanding. Do I ask them to question everything in terms of how easy it is to make graphic content and that graphics is a whole language to itself and visualizing information is a whole study in itself? Yes. Do they take it for granted it's almost too easy now? And that's the sign of how old I am, right. I am saying that it's too easy. But, yes, that's a great question, and do I think students do it enough? No. Do I ask them to? Yes.

Interviewer: What about the student who thinks critically about how these technologies affect architectural representation? Where do you see that in his or her work?

David Jason Gerber: In the argumentation and in the choice, yeah. Students need to be able to argue for why they make an image look the way it looks. It can be to evoke an effect or it can be to communicate simplistically a complex idea or a complex condition.

Interviewer: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

David Jason Gerber: Yes. But, for me it's kind of a dumb question in the sense that architects are meant to be taught to be socially responsible. So does the technology make it more easy to be socially responsible? Yes, because [when] we want to simulate energy, for example, we can do that much more quickly than we were able to. I am not sure how the definition of social responsibility will evolve.

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

David Jason Gerber: So, 3D modeling is not part of that when you say advanced?

Interviewer: Yes, advanced.

David Jason Gerber: Okay, so advanced. What percentage? 25%.

Interviewer: What are the primary factors that you believe may hold back those faculty members, the 75%, who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

David Jason Gerber: Again we are talking about advanced, so everyone is using Rhino, for example. Faculty ability, faculty knowledge, and resources.

Interviewer: Is it also a generational issue?

David Jason Gerber: Sure. We have a 65-year-old design instructor who can draw manually better than anybody I know, but probably he doesn't open Rhino.

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation?

David Jason Gerber: Yes, there is a lot of critical thought.

Interviewer: Do you see that through their students' projects or through discussions?

David Jason Gerber: I think mostly through reviews when you have people trying to provide constructive criticism to students on their projects and also having dialogue about their views of the graphic content and the architectural content and the ideation, I think that's when you see it most. You see it also in some faculty committees on curriculum as well.

Interviewer: Some students present their Grasshopper definition in the juries without showing the reasoning, the design reasoning behind that script. What is your take on that?

David Jason Gerber: That's a great topic. That's a great question, and we could talk about that one for hours.

So, some people think that student work or even professional work should include process description, reasoning, right? So then the question is: how do you show your reasoning? Some people would argue that the reasoning and the process are irrelevant; it's just the end product. And I find both to be important, so I like to see and understand process because if I am going to engage in somebody's project as a conversation piece, understanding how they think influences how I want to talk about it. If somebody asks me just to judge the end product, then I'll just judge the end product and I won't care about process, but that is not my preferred pedagogy. Now very often showing the Grasshopper definition is completely useless, but if you look at my publications, you will see that actually we show them and we describe them so we use them as a reasoning and vehicle of that culture, which is – just because you show the diagram with the definition doesn't mean that the content of the project is in fact achieving your own goals. So, I think that's a very interesting topic; you can write [a] whole thesis on that itself.

Interviewer: How about the sense of scale? Do you think students are missing that sense in their design because of the use of these software?

David Jason Gerber: I think that's also a valid criticism that without building physical models, whether rapid prototyped or not—

Interviewer: What are the opportunities these technologies offer? What is lost by their use?

David Jason Gerber: That's a repeat question that's from before, so it's the positives and negatives, right? I don't think a lot is lost. I do think your issue of scale is a good question. If you are going to be in charge of making space, I think you do need to make models or you need to use augmented reality to understand the sense of space and scale. So, maybe that's a *loss*. I think digital craft is equal to hand coordination and drawing craft. I think there are many ways to have craft, so algorithmic craft, parametric logic craft, rendering and simulation craft are equally important in my view. So, if there is something lost – again, with formal or informal school policies, I think there is a general understanding that we need to support more technology in the education, but we don't want to do that at the loss of architectural intent. That's always a fine line, and I think that's probably normal for most schools.

Interviewer: Can you distinguish the student work, the individual, or even other architecture schools' projects right away, or do you think it's hard because they all use the same digital technologies?

David Jason Gerber: Right in front of you. My students' work, it's all very individual, so I think it has a lot to do with the instructor. And, you know, my approach is I have my own design aesthetic, but I don't impose my design aesthetic in a studio. My job is not to make everybody Zaha Hadid. My job is to make them into themselves and to get them to be critical and engaging in the critical discussion of technology, design, performance, and I see my job in the studio as ultimately a person who helps them to find their voice. So again, you see a great diversity. And that's very unlike things, some other very high signature design instructors where you don't see that kind of diversity. And maybe it's because I am not Zaha Hadid, but she is not that prescriptive either you know.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

David Jason Gerber: Yes, and through my own research, again, which is published: "The pace of technological innovation in architecture, engineering, and construction education: integrating recent trends into the curricula"; you should read it.

The economics of any school is always a limiting factor because all of us want more. We want robots, we want digital fabrication, we want prototyping, we want more software, we want more computers, we want, you know, more digital displays because that's the way the world is; it's all about technology if you ask me. So, do these economic concerns affect us? Yes, in every way, whether it's building science-focused people who need technologies to do simulation and analysis; whether it's historic preservation people, which we have at this school, who also use technology to make their decisions about what to preserve and conserve and how; whether it's just pure design instruction as well; whether it's history and theory in the way that they actually teach history and theory, slides versus PowerPoint, for example. So, I think it's a supremely limiting factor, and at universities also, there is also the issue of the overhead of technology, which is a whole other conversation.

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

David Jason Gerber: Yes, pressure from the profession does. I think at this school there is something called the Guild, which is a professional organization, which supports the school, and they have influence over the school because they hire our students. And we are doing no service to the profession and our students if we are not keeping up or keeping pace with innovation technology, which is the title of my paper that relates to your thesis. And so yes, and they are supremely limiting factors.

Yeah, I separate [it] into two categories. There is the de facto standard category, for example, as you mentioned, BIM, Building Information Modeling technology. You know, for not teaching them the concepts of what that does to a professional practice we are not keeping pace. And then the other category is much more about architectural ideation through advanced digital tools, and you have some listed here, you know, the algorithmic, the parametric, the generative and non-generative, the multidisciplinary analysis and simulation linking digital fabrication. But what I find the most interesting is what does that mean for design? What possibilities are opened up giving access to those of kinds of thinking and technology and processes? So, we don't have access to all of the cutting edge things; we can't afford it, so the economic is a greatly limiting factor. And, yes, it drives me.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

David Jason Gerber: No. I don't think ethical constraints have affected [the curriculum]. They should; for example, the crediting of scripts and the re-use of scripts, I mean, there is a hacking culture, which we want to promote because that's actually how it happens and that's how innovation happens. But, I think we do need to have more conversations about the ethics of what that's all about. I don't read into your question that there is an ethical issue using the digital versus the analog. I won't even address that because I just – no, I don't see that as a relevant question because again the evolution of human culture is technology-based.

Interviewer: Maybe another pressure is to prepare the students for the practice? Do you think it's an ethical concern to the school?

David Jason Gerber: Yes, it's a responsibility of the school to educate our students to be successful in their practices. Now, people define practice differently, and the definition is evolving from the true professional practice to the more broadminded research-based practice to design as a holistic thing; that's not just architecture. However, this school has a very strong reputation in developing professional architects, so we do have that as a faculty, an ethical question. Are we keeping pace with the needs of practice? I think that comes up. There is a lot of professional practice-based education here, so, yes.

Interviewer: Does practice now shape the way we teach our pedagogy, or are schools shaping the practice?

David Jason Gerber: I really don't know. I think it depends on the spectrum of graduates and their interests and the spectrum of professional practices too. I actually think we are meeting the needs in many respects from that full spectrum, from the commercial A&E firms that want BIM-savvy, CAD-savvy people all the way up to Zaha Hadid who's interested in the parametric and algorithmic approaches for formulism and actually managing and harnessing complexity for a cultural content. I think, you know, we are addressing that as best we can.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

David Jason Gerber: From the pedagogy and curriculum point of view, it's managing the room in the curriculum to provide students with both computer skills and the rigor of computer science logic and the reasoning and how you translate architectural objectives, which are not always computable into a digital process. So I think that is the core issue that we face. I think some problems are able to be algorithmically defined and algorithmically searched and optimized, but most architectural problems, if thought about appropriately, are too complex or too synthetic or too subjective to be completely driven by computational means. That means, even in the generative projects, which are using multi-agent systems to create highly specific and highly complex geometries, the designer still makes the choice, and so I think that's the interesting debate going for – in a way, it's the same thing to say, you know, are we are going to reach the AI plateau, the singularity right, where AI, the artificial intelligence, will equal the human mind? So I would like to see that as possible.

The pressing issues then from pedagogy and curriculum, do we have room or the economic pressing issues, do we have enough resources and are we resourcing our faculty to do research that impacts practice that impacts the pedagogy? I think all schools have generational differences in terms of faculty ability and faculty engagement in technology, I think that's normal, and I think that's healthy and that will evolve. I think the other issue is the student engagement of the criticality. As you asked earlier, we need to foster as much criticality of that. In many ways architects are becoming tool makers as well as project designers, and students need to understand what that really means and when they need to be a tool maker or just a tool user.

Interviewer: How about the issue of authorship and shared-authorship?

David Jason Gerber: I think there is an ethics in terms of how we teach students to credit teams, you know. My background, you know, when I worked at Zaha Hadid's office, she credited us, whereas [when] you work in some other offices you never see the people who did the work. Prior to Zaha's office I worked at the AA and the DRL program. All of my master's work [was] teamwork, and we always credited each other. And this is pre-hacking of algorithms, per se, but we always share in the credit. And that's a culture that is actually the academic standard; when we write papers, we do reference and literature reviews. We credit the people before us. We look at a gap [in] analysis, and we say, you know, this is what's original. I think that that part of an academic duty and responsibility in ethics is very, very hard given the pace of technology in the hacking culture. And yet, real hackers also credit their code, so I do think that's an issue. But it's a minor issue.

Interviewer: Collaborative work—

David Jason Gerber: I think real architecture is collaborative; real design is collaborative. Real design is actually social in so many respects; you are designing for the built environment for a population, for a constituency. With even the most formal designers, I find their buildings, like Zaha's buildings, extremely socially based, actually the way they organize people and provide people with an experience. And I think there are two aspects of the collaboration. One is how many people are involved in designing and how many people are consuming the building. I think we do have responsibility to remember that, and computational tools enable us to simulate those kinds of things both in how you collaborate and how you design.

Interviewer: Is it like the multidisciplinary approach at the Design Research Lab DRL, at the AA school?

David Jason Gerber: Well, multidisciplinary to me is you have an architect, structural engineer, environmental engineer, contractor – they have disciplines – and they work together; that's part of what my research is about, actually. But, the DRL is a research lab, which is, I would say, is multidisciplinary in some respects, meaning we bring in our experts like engineers, but it's multidimensional whereas in some years we look at environmentalists, look material systems and the brief, which is, a multiyear brief evolves. And so I would say that.

Interviewer: Thanks, David, for your time.

5) Elizabeth O'Donnell

Interviewer: Regarding the influence of technology in contemporary architectural education:

> **Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school (Cooper Union)?**

Elizabeth O'Donnell: Certainly, the existence of these technologies impacts the pedagogy of the school. They are unavoidable; they're here. Within architecture, we still say, "Are they good, are they bad, are they here, are they not there?" They are here! And so they are affecting all schools and all pedagogies, and now also digital tools are deeply embedded in practice.

Interviewer: Some architecture and design schools adopt a specific technological paradigm, for example, general systems theory, information theory, network theory – some schools do a mix. They refuse to say that they're following one paradigm.

Elizabeth O'Donnell: I would say none of those at Cooper, still, and I would also argue that there is not a single design theory throughout the school. I think we have a clear direction and focus vis-à-vis our approach to architecture. I would say that all of the faculty here at the school would agree that architecture plays a significant role in culture, society, urban life, and – but that methods of design are very, very individual to the individual faculty that are teaching the design courses.

So, where in the undergraduate school, five-year design sequence, it begins with architectonics, it ends with the year-long thesis project. And within those 10 studios, students are exposed to a very broad range of design methods and approaches to design. So it's still very much rooted in the individual ideas of the individual faculty that craft those studios.

Interviewer: How are they integrated into the curriculum?

Elizabeth O'Donnell: Well, it's very basic, and following your introduction of ideas of system theory and network theory, I would say – it's going to sound incredibly old fashioned – but I would say our five-year design sequence, the framework upon which the individual faculty developed their individual projects, are architectonics, which begins with an approach to design that is perhaps preliminary to architecture. So what are the fundamental ideas of space, the relationship of an individual to space form making? So in some ways that's the most Bauhausian idea that I think remains at Cooper and that Cooper has brought forward into the 21st century.

The second year [studios] are the elements of architecture, so very basic and fundamental ideas about site, structure, space, program at the very beginning. And for students it's an introduction to the fundamental beginnings of integrating those individual elements. In third year, our students do scaled public installations as a building project. Well, actually, they do two things so it's analysis of architectural precedents, and then the building program is a small public installation, which integrates all the course work of the third year. So building technologies, environmental technologies, structures, we ask students to really comprehensively integrate all those elements that – or not elements so much at this point – but all those systems that are critical to the making of a work of architecture at full scale.

In the fourth year, students change scale, and in the fall semester the projects are usually peri-urban or suburban in their focus or landscape. And then in the spring, it's an urban project. So architect urbanism, but at the architectural scale – not city planning, but architectural urbanism. And then in the fifth year, students do their thesis. And the thesis project is completely open to the student to define site program, parameters, production methods; all of it is really defined and designed by the student. So that's the general framework, and the individual faculty then are free to develop a program that will fit into that framework, but we rely on in some ways the creativity, the knowledge, the interests of the individual faculty to craft the studios as they feel as best.

Interviewer: How about if a faculty member came with one of those technological paradigms and he wanted to enforce that on the student? Do you think that would take a different direction than what Cooper Union is trying to teach?

Elizabeth O'Donnell: If your question is, can the work look different than what people may think of as traditionally Cooper work? Absolutely, I'll take you up to the seventh floor when we're done because Pablo Lorenzo-Eiroa, who actually was one of the chairs at the ACADIA Conference last fall, teaches the second-year design studio, and he has taken the ninth score grid and is now looking at it as a topological exercise. So not as an elemental exercise, but has taken it in a very different direction. And formally – and so in terms of its form, the projects are very, very different in their investigation of the kinds of space that can be made, or the kinds of space that are being considered in the 21st century that were not in the modern movement. So, absolutely, they can change.

Interviewer: The first year, is it similar to the Basic Course at the Bauhaus? Teaching students abstract thinking, materials, texture, shade and shadow, sculpture, and most importantly geometrical studies?

Elizabeth O'Donnell: Yeah, and I would say all of those are still present in architectonics, but again the kinds of projects that students engage in are very different now than they were when Raimund Abraham or John Hejduk were teaching architectonics. David Gersten's course on architectonics involves perception, the experiential nature of architecture through the construction of a single object as opposed to students working individually on individual projects, where they are investigating, say, a platonic shape or solid.

So it's very, very different in its approach. I would say that conceptually there is a similarity. It's part of the continuum, but at the same time, the students are being asked to consider architecture in a way that's much more perhaps dynamic and nuanced by the technological age that we live in. So David is really saying that it's no longer perhaps possible to just look at isolated solids; it's not how we live anymore.

On the other hand, the other faculty member who teaches one of the architectonics terms is Lebbeus Woods. And sometimes he will have his students absolutely go back to the cube, the cylinder, the cone, and the sphere, but again, not always in the same scale; it's even taught by hand from year to year. So there are years when he has looked at those objects as things at this scale. This year he had students working on projects at a much, much larger scale. That work is in the Colonnade right now, and I can show you that. So, group projects at a large scale where those formal shapes are considered within the program of an ideal house and linked to time: dawn, noon, dusk, midnight, or material elements: earth, wind, fire, rain.

Interviewer: And this is all done by hand and sketch modules?

Elizabeth O'Donnell: I would say our approach to how students choose to integrate technologies into their work we leave very open. There may be moments when digital technologies are necessary to employ because of the nature of the project. So we don't say that it is time for you to use digital technologies as a means of production, of making a project. If it's necessary to investigate the particular ideas that are being presented in the studio, then of course the students will need to draw on technologies. So in Pablo's second-year studio, the students definitely, very quickly in the course of that project began to employ digital methods of investigating these shapes and spaces and manipulations of space.

At the same time, they would sometimes in the course of their project do hand study models as well. In the first year, students really are drawing and modeling in three different classes, in three different ways. So, there is the architectonics studio. They take a course in freehand drawing, which is taught by Michael Webb – one of the early Archigrams, who was involved in Archigram back in the day – what we call descriptive geometry in computer applications. So they literally begin with the old methods of descriptive geometry as a way of describing form, shape, and space and then draw that into an understanding of how CAD systems work, digital drawing systems work. So they are doing that in first year, and so, some students as early as in the first year begin to bring those methods into their work in the architectonic studio. But in the architectonic studio there is also a very strong emphasis on actually making models, constructing models, sometimes at small scales, sometimes at a very large scale.

Interviewer: Do they do these models by hand?

Elizabeth O'Donnell: Absolutely. We have a phenomenal shop facility, and so I would say in first year, most students are working on what we would think of as analog tools, saws and drill presses, blades, that sort of thing. In second year, especially again with Pablo's studio – and Michael Young taught in second year a few years ago – and students began to use laser cutters, some CNC work, not so much 3D printing. And again, it's a process whereby a student as an individual will begin to take their project into a realm that requires or is best informed through digital technologies.

Interviewer: I read in an article that Cooper Union is an anti-CAD school; is this true?

Elizabeth O'Donnell: This is certainly how we are perceived. I would say it's totally not true. I would say one thing that still distinguishes Cooper in terms of drawing an investigation is plan and section. And the extent to which some digital drawing methods are kind of resistant to revealing the plan in the section, and are very surface and shell oriented, I would say we encourage our students to be cautious of those programs.

Interviewer: I got a similar concern from one of my meetings that we're not thinking in 2D anymore. Students do not present their design concepts/ideas in 2D anymore!

Elizabeth O'Donnell: Present them to who? But the idea is not who you're presenting to; it's how you're investigating your own architectural proposal and what you know about it. You don't draw to make a presentation; you draw it to investigate and analyze, and that is what is critical. And to the extent to which an architect only thinks of what they're doing as a shell, I think that's problematic. I mean, at the end of the day, we still walk through a building in plan.

The idea of the building is still on its plan. The organization of the building is still on its plan. And so you may feel that you don't need that drawing to present to a client. And maybe your PhD will reveal that that has always been a problem and a conflict: those drawings that architects make for presentation versus those projects that architects need to make so that they understand the buildings that they're designing. But I still think the plans and the sections are critical.

Interviewer: What do you think are the positive and negative implications of these technological paradigms?

Elizabeth O'Donnell: I think the digital is really interesting and useful in two realms. One is in analysis. And I think the opportunities for students to integrate GIS systems, photography, sensors – we had a student who did a thesis project once by constructing a climbing wall and then attaching sensors to his wrists and ankles and then used the data that he collected from these sensors, which measured acceleration and rotation in his hands and his ankles. And then he linked that data to a drawing system which he invented to make a landscape. And so that is beautiful and remarkable because that's both analyzing a physical sensation and then taking a very creative leap in thinking about how that data may then inform or create a different kind of physical landscape. And so I think the digital is great for analysis.

In our master's studio, we had students investigating natural conditions and phenomena. So, one student looked at the pattern of water that we're developing in the Florida Everglades region and the changing nature of the aquifer there. And she did a remarkably beautiful series of drawings of the changing condition, literally the condition of the ground in Florida. And so tie that to real data of the changing nature of landscape, or what's going on with the melting of the ice caps, desertification in places like Greece. It's very, very easy – it's not easy, but it's possible to really, seriously investigate changing phenomena in the world in a way that would have been much, much more difficult before the digital age.

So I think in terms of analysis, it's really exciting and offers students many, many, many new areas of possibility. And then they're also very useful in production, in the production of models, drawings that reveal these analytical processes. I think where our students sometimes find the fit still uncomfortable is in that space – set of production, like what is the design path in there, and how do you get digital programs to effectively allow you to investigate issues across a very broad field? So plan, section, surface, all of it, perception, light, issues of air, interior environments, all of that kind of thing – how can all of those possibilities be, or how can all that information be brought in to inform your design?

Interviewer: What about that negative implication of digital paradigms?

Elizabeth O'Donnell: I would say the negative implication of digital paradigms is when I look at the work that's going on in so many schools, it looks like a video game. And so the aesthetics of gaming and computer generated film-making, I think, has become incredibly present in the aesthetics of architecture in many architecture schools.

Interviewer: Why is that? I mean, where do you think it went wrong?

Elizabeth O'Donnell: I'm not going to say that it's right or wrong so much. It's just that it's what I see. And, I'll be very honest, I would say that it's just not an aesthetic that has any meaning for me. There's no beauty there, and it has no meaning. And for, maybe, for a 17-year-old – or an 18-year-old or a 20-year-old or a 22-year-old – who spent a lot of his or her life in that realm and in that world, this is a very potent aesthetic that has a lot of meaning. What I don't know is then what the effect of that is going to be for our cities down the road.

And I think, and again this may be a generational thing, I think that's something that's got to inform your thinking about this. For me, I find I can't see the ideas in it. And I don't think it's fair to me to say there are no ideas in that – I am not willing to say that – but I can't see the ideas in that. They're very opaque. And I think, for me – given my education and when I studied, when I was educated, and the great ideas and thinkers of modernism in Colin Rowe and Robert Slutzky and the notion of transparency in/and layering – so for me the plan and the section are these things, these devices that reveal what is difficult to see. I find so much of the new rendering, the interest in rendering surface and rendering the work of architecture as a solid object; there is not an interest in revealing what that building holds in terms of thought and idea.

Interviewer: Have you attended a jury out of Cooper, and what did you think of the projects?

Elizabeth O'Donnell: I'm very certainly honored and happy to go to other reviews. I've been to reviews mostly at City College; I know a lot of folks who are teaching in City. And yes, we have those conversations.

I think the students really are very, very invested in what does the building look like on the outside. But I think that partly has to do with rendering software. I would say the limitation of rendering software is that it positions you as kind of the viewer, the maker and the viewer on the exterior in a way that can sometimes be to the detriment of really understanding what is the nature of the architecture that you are actually proposing.

Interviewer: When they present, they walk you through the plan, right?

Elizabeth O'Donnell: Yes, I guess so. They don't always know the plan. They don't always understand the plan.

Interviewer: How about the sense of scale in their design?

Elizabeth O'Donnell: I think it's interesting you bring up scale because I also think that that one of the dilemmas of working digitally is this notion – I often hear the students talking about paper space, are you working in paper space or real, or are you in real space or paper space – and I think one of the fantastic opportunities they are presented in developing and drawing digitally is that in theory you are always in real space. And then you are scaling up and down depending on what kind of a drawing you want to produce.

But way more often they're not, students are thinking in paper space. And so when you are working over the boards with the student or something and you say, "Well, what's your column for it, and how far apart are the columns?" they're not sure. They're not because they are not really thinking in the scale of the thing. The scale is at the scale of the page or the scale of the paper. And so I think, oddly with a technology that makes it very possible to always be thinking in full scale, students often neglect to keep their thinking tied to full scale while they're working on a project digitally at a smaller scale, and so they don't know how big things are.

I would like to go back to something that you mentioned, which is this idea of once the new technology comes out, people feeling compelled to use it. And they don't always use it critically. And so here we have a dilemma because, when something new comes out, of course people should play with it and test it and take it out and see what happens because [there's] so much R&D in many ways in the realm of architecture, or this is balanced with what research is going on in the architecture schools. And how can the schools then take what they learn and affect practice and how much research goes on in practice? And then practice in some ways begins to drive how architecture schools develop their pedagogies.

I think that's a really interesting back and forth. And I think research is happening in both places simultaneously, and there is not enough recognition of the work that is going on across the design divide of teaching and practice. So for an office to get it, okay, so that's one thing. The second thing is that technologies are really expensive. And so I think once either an office or school invests in the technology, they feel compelled to use it whether or not they have tested that it does what we want it to do. And so it's much more difficult to just try out the technology and then discard it if it's not really effective. And I think that's shown in practice as well as in schools. And so, I would say, if Cooper can be characterized as anything, we are happy to say we are not going to be the first to use any of it. We'll let some machine or device come out, maybe let it go through one trial run, and then we'll start experimenting with it. Because I do believe that our students are phenomenally well prepared to test these systems critically.

Interviewer: We're not here to teach them tools/technology but design.

Elizabeth O'Donnell: Right, you don't want to make the technology the curriculum. And so, if any – and I know our faculty well – so if any of our faculty wanted to, say, make a studio around 3D printing, it would not be so much "let's do things on the 3D printer" as much as "let's really investigate what the 3D printer is capable of." And we, in some ways, have the ideas drive the technology, not to be limited by that thing as an instrument, but to think of it potentially as a catalyst that can facilitate new ways of thinking. And if it can't support new ways of thinking, then it's just a tool. And maybe that's okay because sometimes tools are just faster versions of old tools – like the laser cutter, it's just a faster version of an old tool. I don't think it's a new paradigm in any way; it's just a very, very effective exacto blade.

Interviewer: Should we stop them from using technology then?

Elizabeth O'Donnell: No, we can't stop that. We can't. Now we have students who are 18 years old; they have never *not* lived in the digital environment. They have been in the digital environment since their birth. It's kind of interesting because if you put an iPhone in front of an infant, they will figure out how to use an iPhone because they just experiment with it endlessly. They just kind of test it randomly as they would test any tool until it does something, and they learn that way. They don't need the guidebook; they don't need anything. You just put it in front of an infant; they'll figure out how to make it turn on and off by just trial and error experimentation. So we can't then say to students, "oh, but architecture is something where you have to step back and ignore the tools of your time and ignore the tools that you grow up with." I don't like all the tools, but they are there. They are part of our world. And I don't think there is any need for architecture to say "architecture can only be pure if we have students on drafting tables."

I think of the conversation from the student's point of view as opposed to a professor's. I've been working six weeks trying to get this command to work. If within that effort the student has an idea that they are driving for, that is not just about making that command work. But if they are saying, "I want to wrestle this command to the ground until I understand it completely and I understand how I can get it to make my work better," then we would say go for it. But the student has to have an idea outside of an operation that makes it worth that attention. I mean, 30 years ago we would have had students trying to figure out how to make a metal plate. They wanted to figure out how to weld the medal plate or solder a metal plate and embedded it with wax and cast it in plaster.

So I mean, those are all techniques as well, none of which have any worth in themselves except as craft – and there is certainly a value in craft – but the whole intention is about what is the idea, what do you draw from it, what [do] you learn from this experience? And the digital tools are still tools. And so I think we should both allow and encourage our students to experiment with them in the same way that 30 years ago students were asked to experiment with plaster, watercolor, ink, mylar, ruling pens, all of it. I mean, think of the effort that students went through to learn how to use a ruling pen properly to draw a straight line, hours and hours and hours and hours. When in Cooper, and in Richard Meier's office, there were legendary stories about using a ruling pen to draw a line and then using an exacto knife to cut the end of the ink of the line. The ink had a little bit of radius, so you had a sharp corner, there is an incredible obsession with the tool and the craft. But it was in service of an idea of precision, materiality. So I feel that that possibility remains that students can take their tools and wrestle them to the ground and understand them and put them in the service of making important work, so I don't think we can say we'll go back.

The tool is not the design, and yet a beautiful drawing is a beautiful drawing. And a beautiful drawing is not without importance or authority, so I think it's really important for us that, even if they're just doing work in AutoCAD, that the drawing has to have integrity as both work at its own scale and then referencing the larger scale that the drawing is about.

Interviewer: Do you think that the information era that we're in added to architectural education?

Elizabeth O'Donnell: They are totally hand in hand. Architectural education – even in its most abstract and theoretical architecture – is referring to the making of architecture at full scale. And so the technology of building – and so, I think, technology has always informed architectural education both in the tools that we use in schools and the methods of construction and fabrication that are used in practice. I think what digital technologies have brought to bear on both the profession and education is a pace of change that is really unprecedented. It's so fast.

Well, you made a point [a] little earlier about how the technology itself is changing so fast that for you to become an expert in one tool means that you are obsolete in five years. When we were working on our new building, it was very interesting for me too because most of the staff from Morphosis Architects that was here in New York was very young. And so these were architects in their maybe late 20s who were doing a lot of the detailing and were really the local architects here in the field. They began referring to the recent hires in the office, those who were 22 and 23, as the kids in the office. So they were only 27, but the 22-year-olds, they were referred to as the kids. And they would say, "oh, they can do things we can't even do. We don't even know how to do those things." Like the kids in the office are the ones who are now doing the more sophisticated digital modeling. "We can't do that new modeling" – these were 27-year-old architects!

Interviewer: They're from the same generation!

Elizabeth O'Donnell: Exactly, five years up and so that is very different. It is not as if you ever felt coming out of architecture schools that your skills were potentially obsolete when you were 27; you barely had your license. And that's only partially true because certainly these were highly skilled, smart, really fantastic architects to work with. So I felt my job was to remind them that they are not obsolete; they are now the elder statesmen of the office that know a lot about construction. But there is this feeling that, yeah, your skills in those [areas] are obsolete in five years.

I have many colleagues who have small offices in New York City, and even small offices now are converting their offices to BIM. And it's a big concern up there. I had a colleague come to me once, and she said, "Listen, you have to understand something when you are in there teaching students. Even in small offices like ours – where we used to be able to hire students to come in, entry level students, to come in – and they would do a lot of design work on a small piece of a project, but they would be involved in the design process." She said, "The pressure to put the project on a BIM system earlier and earlier is so strong that the person who controls the BIM model becomes the most powerful person in the office because all information has to go through that BIM model." And she says, "I am worried that it's going to be harder for us to integrate young architects into the office. Now it's going to be harder for us to really participate in that part of practice, which is to be part of the mentoring and educating of young architects." And that seems worrisome to me, certainly.

Interviewer: I heard also they are going to adopt BIM in architecture schools.

Elizabeth O'Donnell: We are constantly getting queries from the ACSA, Association of Collegiate Schools of Architecture, about "Are you using BIM? Are you teaching BIM? How are you integrating BIM?"

Interviewer: Are you?

Elizabeth O'Donnell: Not at this moment. But clearly it's critical for us to. I really feel that Cooper has the real privilege of getting many of the brightest students interested in architecture in America and abroad. We have a very international student body. I feel there is nothing that I want more than for them to stay in practice and affect practice. So we need for them to leave here with everything they need to affect practice. And maybe that's BIM, and maybe that's something else. But I want them to be a powerful presence in the practice of the future.

Interviewer: Where are we heading with these technological paradigms in 10 to 15 years from now?

Elizabeth O'Donnell: I think greater integration between design and fabrication. Clearly construction is too expensive, and it's too slow. And so [cloistered], which I think presents really interesting social possibilities as well in some ways, the idea that an architect in isolation develops a set of drawings that are then delivered to a team of people to build takes the knowledge of that team of builders out of the design process, which is crazy. Builders are some of the smartest most creative and three-dimensional thinkers that there are, and to take all that knowledge and not have it [be] part of the design practice, I think it's a real mistake; it's a real loss.

And so, I think practice will change by hopefully having greater integration, so when all the knowledge bases that exist in architecture and design are consulting with our consulting engineers, with fabricators, with construction managers, there is a tremendous amount of knowledge about building that stays isolated. And I think we need to integrate that knowledge much more effectively so that projects can be built more economically; they can be more affordable.

Right, and then pre-developing softwares that are affecting the building industry – should there be some school? I don't think Cooper is the school to do it, but should there be some school that's educating architects with this specific intention of being part of those large teams of people who are developing software that will affect how architecture is made?

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Elizabeth O'Donnell: Yeah, we have one open studio for four years of students, so from first to fourth year [students] share a single studio. And that has been the model for 40 years; that continues to be the model. We don't have desktops in the studio. Most of our students have laptops. And then we have a sophisticated computer studio. When students really want to kind of crunch their projects, they work in one of our studios either here in the foundation building, or in the new building at 41 Cooper Square.

I think in terms of collegiality and exchange and conversation, we have an incredibly collaborative studio. Our students still by and large work in the studio. In their first two years, they often have group projects, collaborative projects. And so there is an emphasis on developing the community of the studio and teamwork, for all its good and bad, for students learning how to negotiate a team.

Our thesis students then work in smaller studios because really the size of our school is small. [With] the size of our school and the fact that all the students are working together in a big studio, there is a tremendous sense of collegiality and community in the school, and I don't think that's been affected by digital paradigms. If anything, the thing that's probably affected it most are headphones – much, much, more than any kind of digital paradigms. It's much more benign. I know when I first started working in an office, I learned a tremendous amount about communication and communicating with the contractors and builders and fabricators by just listening to the other architects in the office have telephone conversations, and that is a culture where you learn as a young architect just by osmosis; it is very different now. And I think there may be less. So isolation through headsets is different than being in an open studio where all conversations in some ways are part of the milieu of a public space, or a semi-public space because a studio – it's not a private space, but it's not quite public space. It's a space of that community.

Interviewer: Some schools have a blog where professors teach students through online tutorials, (for example) how to use surface software, [and] students ask questions. Do you have that here?

Elizabeth O'Donnell: We don't have that. We use posting services so faculty communicate with students vis-à-vis e-mail groups and Moodle and that sort of thing. Our students have a tremendous individual personal contact with their faculty. And so I would say that is part of the culture of the school, which is not to say that they don't additionally interact with each other digitally. And we have some courses that – we had a faculty member who was ill for the first couple of weeks of class, and he Skyped into his class and taught by Skype. And I have to say, it was very odd for the first five minutes to have the head of the faculty member in the room, but it was remarkably successful after ten minutes. It's just a very odd thing for 10 minutes, and then the class just begins to operate like a class. It wasn't a studio class, but an elective class.

I think one of the things you have to remember that characterizes our school is that we are an undergraduate school. Our students are young, or two-thirds of our students are young. So two-thirds of our first-year students are right out of high school. Probably a third are transfer students that have had some other university work; they start in first year because either they were studying something that's non-architectural – but they are all often older students. Sometimes they have a degree. But for many of our students, this is their university education as well as their architectural education.

So this is college for them. They have very intensive courses in humanities and social sciences; they have courses in what colleges call general education, math, physics, that kind of thing. And we believe in the model of a highly engaged faculty. And a tremendous amount of studio faculty engagement, it is through that. And if you want to go back to an idea of what keeps engagement with technology critical, it is that constant conversation with your faculty.

Our faculty do a lot of pinups still, so even if the studio is digital in its orientation, every three weeks or so everybody pins up and has an open conversation about the work. I actually think one of the most difficult things about digital presentations for me is you never see a project laid out all in one where, with your eyes as a field, you can scan in any direction you want so that you can go in order, you can reserve it, you can go diagonally, but you can really, really think about and investigate a field of drawings as opposed to a sequence of drawings.

So in sequential digital presentations, it's a very, in some ways, conventional narrative structure. It's not a spatial structure; it's a narrative structure. So it's temporal: this is first, that's second, that's third, that's fourth. And so there isn't much opportunity to then invert or investigate that sequence in a way that will bring a new critical understanding to a project.

I'd say in that regard the culprit is not so much the software as the profession, where the profession is eager to ensure that students can quickly render things and make presentations to clients, community boards, landmarks review processes . . . The project itself is not completely thought through. And rather than allowing the drawings to reflect the stage of thought, there is pressure or desire to present something that is finished even though it's not.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Elizabeth O'Donnell: Absolutely, and that's where the really strong community is; our students work together in a single room for four years. And fourth-year students are very interested to see what first year is doing now that's different than the first year that they did. And so they in some ways like to monitor the evolution of the school by watching how the projects in the earlier years change and evolve, and then students in the earlier years have an opportunity to see the kind of work that students in the upper years are doing. So there is a lot of communication back and forth.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Elizabeth O'Donnell: The faculty has to insist on it. The faculty are the leaders, and our students are students. I think it's always a funny thing sometimes when you hear a faculty member say, "My students couldn't do this." But you are their teacher. This is your responsibility. You need to set the standards of the studio; you need to set the intellectual standards, not just the production standards, not just set the program, but you need to, within the context of the studio, set the standards for intellectual engagement and discourse. That is absolutely the faculty member's role.

Interviewer: Do you teach students to push back on and innovate beyond these paradigms? How so?

Elizabeth O'Donnell: Well, you ask them, "What is the intention, what is your desire, what is your expectation, why is this necessary?" But the students also will ask each other that. You know, there is, especially with digital model making right now – because our students value our reputation for the high level of craft that the school has a reputation for – so the students feel very protective of that reputation, and so they will constantly be saying to each other, "Oh, you shouldn't cut that on a laser cutter. You should go to shop," or, "Why are you doing it that way? There is a better way to do it."

Interviewer: Do students think critically about how these technologies affect architectural representation?

Elizabeth O'Donnell: Beyond those boundaries of the technologies, I think you support them, you challenge them, you ask them to take risks, you reward them for taking risks, and for trying things even if they are failures. You remind them that the community of the school of architecture is about taking risks, is about challenging each other. And as a faculty member, that also means that you have to be ready for some of the projects in your studio to be failures, and for them to not look good, and to be really raw and rough and maybe incomplete, but on a track to have a potentially groundbreaking idea come out of it. So everybody is in there taking risks together; nobody is more on the line than anybody else. And I think, oddly, sometimes it's our faculty who are least invested in digital technologies that are most able to say to our students, "I totally get what you are trying to do. I have no idea if this technology is going to get you there, but push it, push it, push it."

Everybody has definitely an open mind – and to just remember that the digital technologies are tools, and we should pick them up and use them or not as they are effective for the investigation at hand.

Interviewer: On social responsibility: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Elizabeth O'Donnell: I think that's a great question and a super important question, and I think it happens maybe less so in the early studios, where in some ways the pleasure of the studio is learning about form and space and light and shadow, beauty. For many students who live in visually degraded environments, and I think for many students – even in the city like New York, which is very wealthy – many students come to architecture schools having lived their entire lives in incredibly limited special environments, ugly schools, experiment homes, tiny apartments. Even we have New York City kids who have never been to the Guggenheim, don't understand the Guggenheim when they are in it, have not been to the Whitney, have not been to Trinity Church, and so they are really impoverished. Their architectural experience is really impoverished.

And so, reminding them of the potential of architecture to have an impact is really important and to further start off by just teaching that. So that should be something that students are reminded in their history classes – that, looking at buildings, you can't just look at an isolated building as an aesthetic object; it had a role in society, at its point in time. Either it was innovating technologically, it was innovating socially, [or] it had a social idea. So in history class, you talk about the social ideas of building.

I think, we try to remind our students constantly of that in third year when they do a small institutional project. So your project may not have the power to change the scale of the city, but it can change the lives of the people who enter it; it can change the neighborhood, how much impact a work of architecture has for us. [We] help our students to be both realistic about what architecture can have and how architecture can be impactful and yet unbelievably excited about how impactful it can be. And then in thesis projects, when we ask the students to think very broadly about problems that exist in the world, we say, "Think broadly." So if it's the melting ice caps, go for it, find out what's going on. If it's the Favelas in Rio, find out about it, find out what's going on. So to take a very broad social problem, and then having done research for a semester on that, now [the] thesis is really thought of as two semesters: one in research, one in design.

Then, after having done that very broad research, you may need to shift scales and say, "How can a work of architecture have some impact on that? It is not going to fix it, but how can it respond to that pressing condition and have some impact on it?" And that's what we always hope the thesis will be, I think: broadly face the problem head on, think of its scope, no matter how terrifying in its reach, and then step back and say how architecture has some impact on this. That's what we want all our thesis projects to be.

I think we've all seen plenty of the evidence of what happens when people don't pay attention; they're greedy. They care nothing about the condition of society as a whole. And you know what? The richest person in New York is going to have a kid that's going to walk down the street with the poorest person in New York. Those kids are involved with each other. And so, it's to everyone's advantage that everyone feels that they have opportunities for happiness and a good life – may not be the best life, but a good life. And I think we feel that we can teach that. I don't feel any desire to step back from that.

Interviewer: What percentage of your design faculty use or require advanced technologies – parametric modeling, simulation, software, digital application – within their design studio?

Elizabeth O'Donnell: So, require? With the – after the word "required," I would say 20%. "Use" is different. Use, I would say potentially 100%. Again, it's the choice of the students.

Interviewer: And what are the primary factors that you believe may hold back the 80% that don't require the use of digital technology and parametric modeling and simulation software within the designs to be—?

Elizabeth O'Donnell: I think we just don't have faculty that think that narrowly about the practice. I think if one of our faculty who normally does not use digital tools all of a sudden came and said, "Okay, class, I'm going to do a parametric project," the students would be stunned and then they roll up their sleeves and they would do a parametric project. But it is really the decision of the faculty.

Interviewer: Is it a generational issue?

Elizabeth O'Donnell: Of course it's [a] generation issue. But I would say that there are many of our faculty who would argue that of all the digital paradigms that may be interesting, parametric modeling is not one of them. That iterative, the role of the architect is to set up a process and then just watch it evolve; they would say that that's not what an architect does. An architect may set up a process, put it in motion, inflect it, change it again, have an impact, critically assess it, and then say, "But what [does] this have to do with space and program?" They may say, "I'm not interested in that," maybe other kinds of digital issues.

Interviewer: Do your faculty members think critically about how digital technologies affect possibilities of factors of your representation?

Elizabeth O'Donnell: Absolutely. We are tackling that all the time.

Interviewer: As a faculty member, what are the opportunities these technologies offer? What is lost by their use?

Elizabeth O'Donnell: That we haven't talked about already? I think analysis has gigantic possibilities. We've the beautiful new building – some people would say it's one of the first digital buildings in New York that integrated digital design and digital fabrication. Not true, it's probably more likely the last handmade building in New York. Except for in certain moments in the building, it's a very classic building in its orientation and conception. It has some spaces that I think are genuinely interesting and new kinds of spaces.

Interviewer: And what about the loss?

Elizabeth O'Donnell: I guess plans and sections.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Elizabeth O'Donnell: Definitely we are constrained in that. Cooper Union is on a full-tuition scholarship model. So we are not like Yale where there can be digital printers on every floor and laser cutters on every floor. We have to choose the technologies we invest in very prudently, and we can't use all of them.

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Elizabeth O'Donnell: I would say that we have many graduates who are in very permanent positions in New York City firms, and one of our graduates is a manager at SOM, managing partner. We have graduates working in office – we have, graduates working in their own office.

So I would say that we are in constant conversation with these leaders in our profession about what the strengths of our graduates are and potentially what firms may find lacking in terms of their skills and preparation. And uniformly, the firms always say, our students are phenomenal, phenomenally inventive and creative thinkers. So they're always fantastic to have on a design team.

They wish they knew BIM. But the question is: do we want to take out two humanities courses and a science studio and teach BIM? I don't think so. I think we would rather have some easy way for our graduates having finished Cooper – if they want to learn BIM to learn BIM so that that can be another skill that they have. But within the environment of the school, maybe we would offer this as an elective course, maybe drawing some engineering students and see if we can't get some really great symbiotic thing going on with engineering. We were watching this very, very closely. And, as I said, our graduates are phenomenally skilled when they leave the school. We don't want them to be underprepared in anyway. So we watch it always.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Elizabeth O'Donnell: I think I would say it's more ethically important for students to be able to understand these tools critically. And so whatever skills they have, they understand their limitations. I don't know if some of the work may be up in the gallery; we can take a quick look at the gallery. But the idea that the students at Cooper do not use their drill tools is a myth. If there is any myth out there, that's a myth.

We do not teach tools in that way. So those tools as tools that make certain kinds of investigation possible are brought into the studio at a time when it makes sense. But we don't have studios that are thought of by the students as "that's the parametric studio," or "that's the BIM studio," or "that's the Maya, the Grasshopper studio."

Interviewer: Some schools like MIT teach students to write software for their design.

Elizabeth O'Donnell: Oh, at least they're writing it. But I think the biggest dilemma about just using software is that you are not aware of the construct of the thing itself. So in some way, as you're trying to manipulate the software, you're trying to get it to do what you wanted to do in the same way that a baby is figuring out how to use the iPhone. You are just trial and error, trial and error, trial and error. But at least when you're scripting, you are in full control of the process, and I think it's interesting. I think it's really, really interesting.

I would hope this would inform your work as well. It's one of the great things about architecture schools perhaps, which is to say very different than medical schools, whereas I would say across 30 of the good universities that have large medical schools, probably the medical education is identical. At the end of the day, all the students have similar programs. They come out with similar – very similar skills, but they're highly aligned programs. I think one of the great qualities of architectural education is the opportunity to investigate architecture within – in different kinds of didactic fields. So that if your student is interested in scripting and programming and that's the part of architecture that you want to affect – but there is a school [where] you can do that. And then if you want to focus more on general design issues and critical thinking and social responsibility, then maybe Cooper is the place for you, or a place that has a more artistic approach.

I think it's really important for the profession to support that because those guys get nervous sometimes that students aren't getting all the skills they would like to get them to be ready to practice in an office. And I think it's really important for the NAAB to support that programs can approach architecture very differently because then students can choose how they want to focus. And there [are] those sets of competencies that everybody needs to have. We're just there because it's a professional degree. But then, outside of that set, now instead of competencies students can take their research and investigation and their desires for expertise in certain ways to very different rounds. It would be such a pity if all the schools became the same. And I think that's fabulous because then we can also all look at each other, what each other is doing – and you can go up to MIT, and we can say "wow, did you see what's going on out there at MIT? It's so interesting." Then I can take my students and say, "Knowing what you want to do in your thesis, you've got to go to MIT and do some graduate work. It would be great, or you got go out to Berkeley or go to UCLA or go down to Princeton." That's part of the beauty of it. I don't want the world to look the same everywhere I go. Not interested, not interested.

Interviewer: The idea of complexity in design—

Elizabeth O'Donnell: But what kind of complexity? Are we talking about social complexity, cultural complexity, formal complexity?

That's just one thing, okay. It's one thing, and 300 years ago, when there was a very different relationship between labor and materials, people were building some pretty complex things.

> **Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?**

Elizabeth O'Donnell: I think the most pressing issues of our time are social issues and the extent to which digital technologies of all kinds – communication, design, investigation, analysis, data collection, and developing new sophisticated skins that are more effective environmental barriers, and we didn't talk about that much. But I think, in summary, it's the potential for new kinds of materials and smart, complex skins that can have many bits of program [done] to them. Really, really, really interesting.

Interactive skins, the work that's going on now at UCLA with the metal skin surfaces is really, really interesting. And potentially there are social environmental issues that are hugely pressing. So, the extent to which we can employ digital technologies to both solve them and to invent moments and conditions of beauty, then there is tremendous optimism and great transformative possibilities returned to architecture.

I think the other thing about the history of these things is to look at the relationship between word and architecture because there is that great moment in Victor Hugo, and then Notre Dame, where he says this will kill architecture as the container of meaning. And I think maybe if we now have people who are thinking spatially, but actually never drawing and only writing text and math, maybe there is some other new shift that's coming up about the relationship between language and architecture because I think that has gone back and forth through the centuries. And whether architecture will become less important culturally or more important culturally has to do I think with how successful potentially those scripting experiments are.

It's an experiment. We have a graduate who worked at Cecil Balmond's office – Cecil Balmond, who separated from Arup and now has his own office. He is an incredible structural engineer – but so now he is trying to do his own design work. He wants to be an architect. He is a brilliant structural engineer. He is not doing very well as an architect, I think. Okay, so, I think the key again is to not say that science is beginning to inform architecture, therefore the scientist should become architects. No, they share their information with the architects.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Elizabeth O'Donnell: I think we almost missed it, but this notion of materials and the changing nature of materials – and for there to be a rethinking between the notion of structure, skin as being too sub-structural. Skins are becoming, or having embedded in them, multiple programmatic issues. And, very exciting, the ideas of Toyo Ito working with structure and taking a solid – so this used to be a structure on a plan, and he expands it and puts program into the structure.

So the changing nature of the relationship between programs, structure, and skin and how digital research is impacting them. It's super exciting. And I find that certainly much more interesting than those digital exercises that occur parallel to architecture without really engaging what I think of as those three critical issues of the structure, the skin, and the program of the architecture.

Interviewer: Thank you for your time.

Elizabeth O'Donnell: You're welcome.

6) Evan Douglis

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school, Rensselaer Polytechnic Institute?

Evan Douglis: Well, I think they shape and influence the pedagogy of architectural schools throughout the world. And so there [are] really two different scales of answering that question: major proponent to address the advancements of technology whether we're talking about software or hardware, whether we're talking about digital manufacturing, and in the context of software, there [are] at least three different avenues within which one can utilize software opportunistically in the development of architecture.

One is a generative tool. So scripting would be a perfect example of this. Those that are writing scripts, Grasshopper – there is a whole range of plug-ins that are available today that allow the author to have an enormous amount of control over certain parameters and then, like a musical instrument, begin to conduct some preferred effects. They don't make architecture in themselves. It certainly has to go through a far more complex, how should I say, assessment arena in order to make it more meaningful. But I think that's an enormously valuable opportunity afforded with that kind of digital platform today, which is very exciting. So you are almost – metaphorically speaking, you're growing architecture; you are not imposing one aesthetic or design style onto it, but rather working in collaboration with this kind of technological apparatus to enable certain potentials to emerge that you wouldn't be able to acquire otherwise.

So that's your generative software and then, of course, there is software that is parametrically based, which is looking at the performance of buildings, whether we're talking about the building assembly system, through BIM, Building Information Modeling, or we are looking at the energy performance of what you design as a building. So the software becomes analytical, but it addresses very specific interests that are necessary in the context of making a great building, and this interfaces with the profession. So, it's really interesting that your tools offer certain bridges or connectivity, or they distinguish architectural production in the case of the generative work. Probably most firms in the world are not using it, but certainly the leading design firms are.

And then the third is much more traditional position, where software becomes a representational machine, where you've designed the building and now it's a matter of presenting [it] in such a way that you can communicate to others and hopefully brand it and sell it to the world. This happens to be on the computer, of course. It's a whole search of new machines that are in the process of being assessed now with respect to 3D printing, which represents an enormous opportunity for the profession at large. For the most part, 3D printing in both academia and the profession of architecture is used as a study model, and typically, the material has no capacity to become the final artifact as a building component. But it's a transitional object that empowers us to be able to, in a relatively short period of time, assess certain morphological or topological interest.

So when 3D printing came in, it was a major breakthrough and asset, especially for those interested in complexity and modularity and repetition and mass customization and so forth. But I think the next wave of innovation will be 3D printing machines that will be able to move right from the computer into a building component. And the building component will be a composite or hybrid of materials. So that, in the context of ecological design, there could be a variety of different programmatic entities that are coexisting as one holistic body, not like ours. So a certain proportion of that territorial space would be the sum – the acquisition and transmission of energy, as in the case of a solar shading agenda.

So how beautiful would that be that this component could be printed and then when connected to a replica? We can actually move energy through the unit to the series and then ornament, so it can have building systems, airflow, energy flow, water systems combined with certain cultural expressions with respect to ornaments. So amazing – there is a wonderful example of how technology in the future would be able to take what is traditionally understood in discrete parts and even different disciplinary priorities and bring them together as one beautiful creature so they could be hopefully economic. And this bigger issue here is how do you achieve it technologically – that is this next era of 3D printing – and then how [do] you make it cost effective? Both of them have to be overcome.

But considering moving them to the side, if you are able to achieve that, that larger premise then you totally radicalize the industry, because . . . the huge silos we have, the academy in one and the practice in another and the construction industry in the third, as in manufacturing the parts and then the assembly of them – the sooner we find a way to produce low walls where an increased amount of engagement and collaboration takes place, the sooner something of this kind of proposition will ultimately emerge and be able to spin out to the marketplace. So for those that are interested in truly making buildings more ecologically sound through forms of biomimicry, for instance, this could be one of the numbers of different technologies that could be utilized.

For those that are interested in sustaining a certain set of aesthetics, as we say, expressions or the power of ornament and decorative surfaces as an imprint for culture, then this could certainly help us achieve that. And it really means that now you need that; you need a massive moment of innovation within this particular area. But you need to bring people together that traditionally remain autonomous or meet later in the moment of the genesis of architecture. So I think it's a fantastic future and one that I'm very excited about.

To now move closer to our school, this technology has an effect on our program. As I mentioned before, we happen to be in a technological institute, so we have the opportunity to think from the start how science and art can work together in a more proactive way. It's not either or. It's not, well – I'll develop the design of the building and then figure out how to make it stand up or assess how it will perform environmentally, but as part of the ethos of this entire academic institution. And we also have enormous resources in the context of the portfolio that we also discussed earlier aside from having the professional programs, which obviously most schools have otherwise they wouldn't have – in our Acoustics department and a built ecologies area that has CASE, the Center of Architecture Science and Ecology within it – so all three of those areas of research utilize a whole range of technology to be successful within their internal disciplines. And as a result, there is an affinity now between the undergraduate and graduate students who are getting the first degree in architecture in terms of having an opportunity to engage in three of those camps.

The third one, CASE, which is more explicitly "architectural" because it's actually looking at next generation building components and its located in the offices of Skidmore, Owings & Merrill, SOM, in New York City in Wall Street. And part of its mission inherently is the necessity for an interdisciplinary conversation between civil engineers and engineers or scientists, physicists who understand wind flow and energy acquisition. They are working on a range of projects where they bring post-docs and PhD Students and Masters of Science students and engineers and scientists in rooms together to work collaboratively on these projects with State and Federal funds.

So, the larger aspiration there, similar to my commentary on 3D printing, is that in the context of pursuing maybe between eight and fifteen different strains of research – basic research – that it would move into an applied arena and finally move out into the marketplace in terms of the building industry. And they produce full-scale prototypes,and they move those prototypes into test beds. So, there is a concerted effort to take this interest in reassessing the kind of flesh of architecture and so far as it will have an impact at a larger scale around the world.

Interviewer: Is your school adopting a certain technological paradigm, for example system theory, information theory, or a network theory, like a theoretical framework in teaching? In a systems theory, they focus on the unit and how it's more important than the whole, so their curriculum or their assignment in the studio focuses on that.

Evan Douglis: . . . I certainly agree that in the creation of anything, not specifically architecture, there are always analogical models. They could be in architecture, they could be in philosophy, they could be in economic theory. They could come out of, for that matter, any discipline. And so that's happening all the time whether we're aware of it or not. Certainly in the context of putting together a course or trying to structure organizationally a school or a department, there is an underlying logic that applies. Where I'm cautious is – I'm rather uncomfortable to name things or to [designate] educational curricula because it may oversimplify and generalize a program.

On the contrary, I would prefer to talk about the multiplicity of interest, not the singularity . . . I think a great school ultimately should have different schools of thought inside of it. I think that you want to hire faculty for instance and you want to embrace students from around the world with different backgrounds and different belief systems.

. . . The success of any educational agenda is based on this, telling the student, “Look, we’ll do our best to educate you, and we’ll certainly be as rigorous as we can pedagogically to define a framework within which you can think critically and maximize your creative and intellectual potential. But ultimately we want you to create your wings and fly, and we want you to go on to the world and become a leader and maybe find your own voice if at all possible.” I mean, we ask you to do it while you are in school too, but can you distinguish yourself? Can you leave a mark in the world that – well, hopefully it’s benevolent in a sense that it can be shared with others. But at the same time it celebrates your unique vision.

And you acquire that by having experiences within your architectural education which are different and varied and sometimes even found in antithetical or in great juxtaposition to each other. So when you started to describe systems theory – do we have faculty, for instance, that generate architecture from the bottom-up out of a unit? Yes, we do. And I’m very sympathetic to that way of teaching because there is a high degree of specificity that emerges out of the bottom-up system. And the big challenge there is, in a project of replication and repetition, how do you avoid infinite sameness and move towards infinite variation?

And this is not an aesthetic question; this is not a compositional one or a formal one. This is emblematic of celebrating difference, whether the difference will finally manifest in response to where the building lands in the world globally and is able to undergo change in relation to its site and its cultural specificity; there is a perfect example. So I’m suggesting that the system that generates again the flesh of the architecture is part of a larger conceptual and programmatic agenda where one is continually trying to address change in relation to place and moment and certain criteria that are shifting.

. . . I think in a perfect world, you would be working simultaneously between a bottom-up and a top-down system. And although you may start with systems theory in the beginning, there may be another one that replaces it even temporarily that suggests there has to be an intellectual scale or shift that if you get too caught up in the specificity of the unit then you are going to lose sight of the world.

So, at what moment you embrace the world, certain cultural ideological conceptual interest begins to speak against the work. So again, it becomes more charged and more meaningful.

Interviewer: What do you think are the positive and negative implications of this?

Evan Douglis: Well, I think that what’s unique. I’m in the older generation of the list you’re interviewing. So my own architectural education moved through analog, and then until I graduated and started to teach, it wasn’t until then I realized the profound value of learning how to work with the computer, both as an educator and as an author. So I think my position on this is that of one who wants to embrace as many tools as possible because they are extensions of our body and our imagination. The larger question is: What are the terms' criticality by which those tools do positive and meaningful work?

The computer and the digital age comes with an enormous amount of speed, acceleration, and a predisposition to produce a lot of "stuff" very quickly. It's kind of like learning a musical instrument, right? You need to learn the fundamentals and assume enormous amounts of control with less variables first before you can take on the colossal ambition of all the options available to you. So, in that case, if one is learning or teaching on the computer then there has to be a form of intended resistance built into the pedagogy to be able to slow the project down so that student is able to respond to the outcomes and, again, in a meaningful way that has value and can be used internally by that student-author to move forward. Without that pedagogical clarity, it is easy for the predisposition of the software to impose its will on the author.

This is fundamentally an opposition to someone who may pick up a piece of chip board or a piece of wood or piece of clay and have to figure out how to engage within the kind of material resistance of those slow materials in order to generate form, meaning, space, architecture, whatever we want to call it. That's a slow system, and on some level it may be seemingly easier to control. It just needs a different pedagogical set of operative techniques, that's all.

So I impose no value system on the tools. Do I see traps? There're traps – there were traps in K through 12 meaning that the eye dominates independence of the mind and you are simply recycling clichés that you've seen before. That just means you disengage with the work in a critical way, and what's happening is that whatever recollection you have of architecture as image, that's assuming the privileged status.

So, certainly as an educator, I will always be critical when I see something that's superficial, when I see something that's derivative, when I see something that has lost any kind of either intellectual or even operational and compositional rigor . . . There are opportunities for architecture to be developed as autonomous objects, but I certainly don't think one wants to subscribe to that. It has a totality for the next – our entire generation of students, but that's kind of a segue comment. But yeah, the question is not the weakness of digital architecture; the question is the lack of accountability on the part of the author.

Interviewer: What technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

Evan Douglis: Well, to return to the earlier comment about art and science, I actually think that we're positioned in an enormously interesting moment in the history of the world where the very survival of our species is at risk. And the role of architecture can play a primary one in order to avoid that demise. So it has to do with the environment; it has to do with the energy.

And so, I think, it would be totally irresponsible if our discipline, and that includes academia and the profession, didn't reassess the way in which we teach, the way in which we practice, the way in which we collaborate, the way in which we fund the economic models that are in place. That something radical has to emerge as a new model or mode of engagement, which allows, as I cited before, a far more robust interdisciplinary collaboration.

If that would happen, then it seems to me the questions of architecture would be different, and our response to those questions would change. I also think that the physical manifestation that is how architecture moves into a material condition would fundamentally be different. And that's why my comments about CASE I think are so interesting. Because I think it represents an area of research in our school, a new model of architectural education. Now, do I think it's easy for that to be achieved? No, I think it's very, very complex, most of that research – an awful lot of time in terms of years working on research that takes that long. And it's more difficult to figure out how an undergraduate curriculum can have access to it, although we do link to it.

I'm just speaking now as a dean, where I realize that, on the one hand, we have fundamental knowledge and skills that have to be transmitted to students. On the other hand, you want to go beyond that foundation so they're able to do an enormous amount of applied work, even if it is theoretical, that engages the world, questions. So I don't think we have figured out as a tribe, and I'm saying architects, how to link a more empirical and quantifiable agenda, which is science, to a more political, speculative, exotic experimentation. I mean, this new hybrid species will take an enormous amount of work, and it's much easier to find it in a graduate or post-graduate moment. But I'd like to think that it could find itself into early education in the context – the beginning student of architectural education, the B.Arch, Bachelor of Architecture.

To me, that's a radical paradigm. And then, as I mentioned before, everything about the 3D printing – they are already printing flesh as in biological material. I think biology and the way in which the kind of building blocks of material on the kind of nano-scale will be reassessed and conceptualized and produced in the next 10, 20, 30, 40, 50 years will inevitably change the material base, the palate of potential construction in architecture, which is very, very exciting as though you could bake the synthetic materials that are very much like living materials.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

Evan Douglis: Changes affect the social structure within the studio culture . . . The traditional separation between the studio and the shop will at some moment, or has already begun to, disappear. And so – as far as the desktop printers are able to reside alongside laptops – so you can actually sketch on the computer and see a small miniature version of either a miniaturized replica of something that you're interested in, or full-scale, I suppose in the sense.

That is absolutely necessary to be able to be critical, self-critical, by reducing the distance between them and the time . . . We have an initiative within the school called the Bedford Studio where we have a chair for a world renowned engineer who would teach a seminar in a traveling workshop around the world that's comprised of six civil engineers and six architects.

So, in that particular case, you challenge the traditional separation between disciplines, where – and maybe in most schools they show up together in a conference or in a symposia or workshop – in this case, they spend a whole semester together. And we do that. We have another, a performance installation, and it's called PIP (Production, Performance, Installation), which supports projects to be developed between the Schools of Architecture and Humanities, Arts, and Social Sciences at Rensselaer. [It was] founded by Chris Jaffe to support student productions and arts projects at Rensselaer.

But it's also a collaborative interdisciplinary initiative between students that are coming out of humanities or also social sciences, and they engage in combinations of installation, sound, music and dance, which is great. And so those students will come together and work for a full semester as well. So, if I understand the question correctly, it seems to me it is moving into the social domain of the studio. And do I see changes that are emerging at that scale that are interesting and—? I think so.

Interviewer: What about the use of blogs for a design studio? Or a class where students hand in their projects, and they can talk to each other over the blog? And some professors provide tutorials of how to use certain fabrication technology or even scripting.

Evan Douglis: Yeah, those are great. The whole movement of open source is fascinating, especially scripting, when you spend enormous amount of time – I mean, you could spend months, and I know this from experience – trying to work out a script for very specific effect, and I'm pleasantly astonished. And I hold a great respect for this generation that feels very comfortable about sharing that information. I mean that's pretty remarkable that they will have such confidence developing or moving their ideas into these equations and then into this kind of virtual arena of design that they would give away their authorship, and it moves in both directions. It's beautiful. I mean it – I suppose you could argue that that's one of the powerful opportunities afforded with the World Wide Web, where large populations of people who have no contact with each other physically have an enormous amount of connectivity through this virtual world. And a generous sense of exchange is taking place, and that's beautiful.

Interviewer: What do you think of shared authorship? A student could use someone else's script in a different school or part of the world and use it to solve his or her

design problem. It's hard to have the authorship of a script because they can share and borrow; they can even edit or add/build on it.

Evan Douglis: Well, it raises – important [questions]. One has to do with one's ethical position as a creative individual, and then the truth is that we are all acquiring information and knowledge and insight and all the stuff from our colleagues and from our mentors and from legacies or generations of people before us, whether it's through film or books or video or so forth. So the issue of acquisition of a ReadyMade is not for me the problem here. I think the challenge – and everyone should just kind of know that – is that you have to make an interpretative leap with whatever you inherent.

So if you get a script, then it seems to me you should be able to analyze how the script has been conceived in relation to the outcome that it offers. And if you understand the underlying logic or significant modifications, [you] will enable it to perform for your interest, not the colleague that you borrowed it from, so that it does become yours.

I mean, obviously, you have to transform it, and that's the sign of innovation, that's the sign of creativity. And anyone who chooses not to do that, at the end of the day it's – although you may get in trouble on an ethical level in terms of intellectual property rights and all that – but you lose out. I suppose I am speaking as an educator here because if you don't have that ability to think independently, then you are going to have to be acquiring architectural imaging and scripts through the rest of your life because you don't have your own voice. So, yes, I think it's fine that they exchange it. My sense is – the stronger students, their ego will emerge, and they will find a way to transcend that kind of original state.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Evan Douglis: I think you made a point of highlighting the fact that you can have a virtual classroom . . . I think the one that is most extreme is that you could have classrooms across the planet that are interconnected through Skype and conferencing and so forth. And that has merits, and it also creates certain problems. But in principle, can technology be conceptualized as a rubber band that moves from glue to a kind of infinite tether, and however virtual it is? Yeah. And, again, I think if that is what we inherit as a generation, now the question is the people who are in a position to coordinate and manage, direct, and curate have to be very conscious on building adequacy at the same time in terms of opportunities.

So, again, I don't want to generalize. I think it's exciting, and I would imagine that this new generation is far more comfortable with moving in and out of virtual worlds and operating at various speeds. So when they move forward in their careers and become directors and deans and administrators of any kind, the technology will probably shift as well. They may find again another paradigm shift where there are different types of classrooms.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Evan Douglis: Well, I think that virtual environments as we've inherited them reside in the computer and window. I think one of the challenges that we're facing – that, it's very exciting – is that there are many people trying to figure out how to develop next generation immersive environments so that there is an interface between the physical bodies, a hectic condition and then the virtual world.

So it's not machines and the human species, but the two in a kind of transhumanist view are potentially intermingled, and part of that will happen at the nanotechnology level, part of that probably will happen in terms of the flesh of architecture – whether it's an exterior skin or an internal skin being able to transform in real-time – and there will be a closer alignment between the body as a body of desire, and then the architecture as an extension of that desire in terms of transforming and changing.

So biomimicry might be that the skin of architecture would modify in relation to the path of the sun and in turn move and distribute energy through the building when needed, but also maybe undergo sudden and dramatic changes in terms of . . . something that's maybe entirely transparent to a CamoFlash system for a variety of reasons. Then I'd argue that same logic could be reversed, internalized into the building, and the play between human bodies and surfaces – as in furniture, lighting, air controls, visuality, visibility, optics – all of this is at the disposal of the author, the architect.

And my sense is, then, that while two human beings may not be in the same location or space in the context of classrooms, that – if these immersive environments require certain degree of intelligence – that there could be a sentient experience, haptic, physical. It's not just "I see this person on the screen" or . . . we are working together on a design, and the 3D printer comes out with an object we both designed, but that somehow the disillusion of the current boundary between the real and the virtual will increasingly become less important.

Interviewer: And that's in the design studio?

Evan Douglis: It would happen in buildings, but ultimately the classroom . . . It's the collapse of space.

Interviewer: Also, the idea of multi-disciplinary, maybe it's the path also for the future? People from different backgrounds—

Evan Douglis: Well if you want me to go really far out, we will create avatars, and I would send my friend over to Paris or Kuwait to sit down and talk to him about a project while I am here working as a dean of RPI. So, to be honest with you, I love the idea of projecting into the future because I think we all should as much as possible.

Science fiction to me is not simply a form of entertainment. I think it's a journey of projected, imaginary innovation, and if you were to track the influence that science fiction has had in the history of the world, you would realize it plays an enormously important role. It's almost like dreaming in the safe place. You don't have to worry about whether anyone believes in you or believes in the idea; you can't be laughed at, and you don't have to worry about how it ultimately gets implemented because it's a fiction. But isn't it interesting that it functions as a kind of time capsule, science fiction, because it could be 10 to 100 years ahead of its time, but many of those ideas that land in science fiction will ultimately become realized? Someone will pick him up and say, "Well, this is a great idea." It might be a scientist, it might be an engineer, and it might be an artist or a politician, for that matter. Anyway, it's interesting!

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Evan Douglis: . . . I think it's through seminars and readings within the design studio proper that you are able to get the critical distance from the arena of artistic production you are engaged in. Like, you are talking about being able to step back and understand the consequences. If you're working in the context of the world, or maybe the history of architecture, or even to the extent that, the technology that you are using has a pretty [strong] disposition to impose a certain bias or will on one's work.

That's certainly the aspiration of any great school of architecture, and I would like to think that it plays some kind of role within the specific domain of a design studio that you want the student to engage in your pedagogy, at the same time be able to kind of assess where they are in relation to everyone else, but also outside that studio. That's part of that maturity, and part of that is being literate.

Interviewer: Have you experienced this before? You've seen a student that was critically engaging or questioning these paradigms?

Evan Douglis: Oh, sure. In our thesis [courses], we have some brilliant instructors: Chris Perry and Carla Leitao and Julia Watson and Ted Ngai. And I would argue all of them, on some level, share an interest in being a technologist – guys who prepare technology to help us move forward as a discipline in the world at large – and they do it different ways. So there is an enormous amount of projection, but at the same time, I think the four of them are wonderfully intellectually engaged, and there is an enormously sophisticated discourse that surrounds the research in the early stages and then the design development later on.

. . . I think we are very, very successful at this moment in a five-year program; with thesis, we call it the final project. And so, the criticality you are talking about is not in opposition. It's not absent. It's not across the street in only the seminars. It's totally integrated within the design development of the world.

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Evan Douglis: Well, that's an interesting question because, at some level, all the students in the studios use, engage with, one or more of those. The question is: how integrated is it within the pedagogic agenda? I think, in other words, the occurrence of interest among student populations that are independent of the teachers is part of their generation. They're all are going to pick up on software at some level.

They may not use it as rigorous[ly] as they should, but this is part of their upbringing. And, for the most part, I would say not specific just to RPI, but most architecture schools are embracing new technologies in a variety of ways. Of course, it's the responsibility of the school to take the lead on this, and part of this, when answer[ing] your question, is a generational issue. I mean, there is a certain age group of faculty that inherently is comfortable with sitting down and showing software practices and techniques to the students in the context of a generative project.

And there are other faculty who may intellectually find this [of] enormous interest and value, and we either have to get a digital assistant to the teacher or the students have to engage in a workshop. So one of my priorities in the school since I got here is I am trying to figure out where to get the resources in order to change the curricula so that there are instructors that are available to teach the software outside of any of the studios, and that there is a very well-coordinated interface so that any instructor who is looking for digital help will be able to link to these instructors, and the students will know when there are workshops, and so forth. So in other words, I acknowledge that because of the generational difference the senior faculty may find it requires a greater amount of effort to be able to oversee and curate a digital project compared to the younger, but they bring to the table an enormous amount of wisdom and experience in other areas that are inevitably important.

So, it helps to think of the school as the classroom and [of] the way in which a number of courses and teachers and workshops and other initiatives are linked together holistically in order to address certain priorities. It's not specific to RPI. Think about it. Every era, there is a class of architects that come out that has been exposed to the education of architecture, and with it, a variety of knowledge and skill-sets have been privileged.

As the world changes – and certainly there are things that have happened in the last 10 years that are absolutely remarkable – how do the senior faculty or, for that matter, principals and firms all over the world adjust their position in relation to these technological transformations? And it's not easy, and some will unconsciously or consciously assume a position of resistance. I know it sounds funny, but there are firms – like even Richard Meier was very uncomfortable leaving ink on Mylar drawings to get onto AutoCAD, and you can't criticize him for that. There was a fantastic legacy of apprenticeship that took place in an office like his during that era that was all about considering each and every line as an area of selection. [Lots] of faculty in our profession . . . are caught-up into romanticizing the past, and that's seriously problematic, like the past is good and we should always be assessing history in a contemporary, vibrant way to unleash ideas and potentials out of it.

On the other hand, you also need to embrace the future, and it's just being practical that an older faculty who hasn't worked with the computer is going to have more difficulty figuring out how the students that he or she has inherited should be critiqued and how the pedagogy should manage this.

My answer is that you shouldn't assume that the teacher is a single source and that, in the spirit of collaboration, you want to make as a many formations and coalitions as possible, official or unofficial. And if insight into the computer can be offered through a digital consultant, which is what we always had at Columbia University during the '90s, then so be it. I wanted to make a point there: let's not equate having technological or digital experience with a form of pedagogical supremacy. That would be a misinterpretation.

Back to my comment about schools being multiplicities, I think a great school will embrace the senior faculty who have invaluable knowledge about former pedagogies and histories of architectural education, as well as the younger ones who have these new toys and work with them beautifully in a beautiful way. So the classroom is just a frame, and it's a temporal frame. So what you have to figure out is how a multiplicity of frames begins to superimpose, interconnect, and link in creative and productive ways.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Evan Douglis: Economics always has an impact. I mean, you can't use it as an excuse not to be successful. You are going to have to be successful no matter what. So it doesn't mean that great schools have more money. But what it does mean is that, whatever access you have to funding, you have to be as creative and strategic as possible in order to maximize it.

When I got here, there was a laptop program – probably like every other architectural school in the world – as a kind of deployable drafting table, but if you are doing very sophisticated modeling parametric or computational, you are going to need a very powerful computer. So I advocated for a computer lab in the school, and I was fortunate to be successful. I got the President support, and there's 36 seats of Alias top end computers. They're pretty beautiful machines. Half of the room is dedicated to a specific vertical studio that will situate itself in there, and the other half is available as seats to everyone in the school 24/7. So there was a case where I had to get funds to be able to pull that off because it's such an expensive investment. I'm certainly doing my best to try to upgrade the shop and would love to be able to get some robots here. I keep my eye on that.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Evan Douglis: I don't design a school based on NAB, or I don't just shape a school to produce drones for the market, but I do something we discussed earlier. I absolutely think that in the spirit of low walls that it is in the best interest of any educator – for that matter, administrator, dean – to be conscious of the forces and priorities and trends that are taking place in the professional world in order to adequately assess whether the education of an architect is responsible, is contemporary, is empowering.

Interviewer: A responsibility—

Evan Douglis: It would be irresponsible to say that you are not going to use any of this technology when the world is using it. And then these students go on; they can't get jobs. I mean, not only [will] you probably lose your accreditation, you will destroy your reputation, but you would do a service to the profession and to the students in your school.

So I want our students to be leaders, and there is a variety of ways to accomplish that. One is to make a content vibrant program, and that's both in terms of the curricula, the faculty, the kinds of opportunities that are afforded them. And it's not just teaching and learning. That's international programs. That's international workshops. I mean, there are a lot of things – introduction of any collaboration.

Well, technology, again, as a generative tool – using the computer, technology, as a manufacturing tool, the building as an agent for change, and the impact it has on the world. And so, certainly you want your students to be global citizens, and whether they are dealing directly with ecological issues or civil and societal issues, you want them to recognize that architecture has the capacity to transform the planet in a variety of ways. And it's a gift, and it's precious, and it should be revered, and it's a very special act to be able to put a building in the ground and move away from it and let it speak for itself . . . Do I think there is a social project here and at the end of the day – doesn't technology have to reside within a larger framework, which is aspiring to do good, great work? Yes, of course.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Evan Douglis: I think there's probably at least two things. One is at a time where there is globalization and there is a rapid surge to modernize areas around the world cities, towns, villages' infrastructure, the potential risk there is to make a uniform, singular homogenous world and that architecture will impose itself on the world in terms of trying to negate consciously or unconsciously the cultural and ethnic, and how should I say, historical differences that make all of us a community, a mosaic.

And you see it in places; maybe 10 years ago when China was acquiring an enormous amount of capital and there was a huge effort to rebuild cities, they were wiping out, beautiful historical fabric. That was really sad because there was no one at that time assessing how to integrate the historical fabric with the contemporary fabric. And how do you keep and retain the integrity of your culture from the perspective of storytelling so that a lineage of ideas can co-exist as a kind of beautiful textile. Again, it's not the technology; the problem is with the capacity to move at a rapid speed, and that incorporates economics and politics and building and everything.

It's the necessity to reflect upon what is important and what is trivial. And so, I do think that one of the major challenges that we have as we move forward is, aside from trying to alleviate strife, to celebrate and empower communities of people towards a more democratic – however they want to find that – world. So citizens have voices. That's partly due to the political institutions and the wellbeing of different communities. From the perspective of architecture, I think it has to be used as an enabling tool, not a weapon. And so, we have to be careful that this rush to modernizing and assertive, highly uniform, stylized agenda doesn't usurp some wonderfully powerful motivations and legacies that should be able to inject and continue through the body of architecture.

The other one is back to our discussion about energy in the environment. Again, that's another area of the world or aspect of our existence that's at stake. And I think if the first one has more to do with the kind of cultural and artistic and politic ethos, the second one is trying to maximize our creative imagination with respect to the science of architecture. And so far these things can work together; I don't necessarily see them as independent. And even if they are independent, at certain moments they certainly could be recombined. So great buildings could satisfy both interests. I think those are two of the biggest challenges in the next millennium.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Evan Douglis: No, I wish you the best moving your research forward and become a leader!

Interviewer: Thank you, Professor, for your time.

Evan Douglis: And you realize that my final comment would be in the context of trying to address or take a position on architectural education: it's okay if you end up with more questions than answers.

Interviewer: Thank you.

Evan Douglis: My pleasure.

7) Gil Akos

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school (Pratt Institute)?

Gil Akos: Yes, they do.

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school?

Gil Akos: Well, I'd say that due to the size and nature of the Institute, the School of Architecture, and the two programs that exist within the School of Architecture (the undergraduate and graduate programs) – that's in architecture, there's also urban design, planning, and etc. – I'd say that the models and paradigms associated with digital technology are very diverse. So there are people that are very interested in digital technology through the lens of how they might use that to create form, but there's just as many people that are interested in it in terms of how they might materialize artifacts that come from, let's say, a CNC machine.

Interviewer: So there is no one paradigm that Pratt Institute is working under? A systems theory or network theory, for example—

Gil Akos: No, I don't think that as a whole you'd be able to identify that sort of prescription to one. I find it very interesting personally because it is diverse, and I think that that's a really interesting way to run a school or at least the kind of instigative school to move forward through design. So I wouldn't say that there's any particular one model, but I would say that the means by which the pedagogy has been implemented may have a more direct set of strategic objectives as opposed to an overriding theme that everything is evaluated against.

Interviewer: How are they integrated into the curriculum?

Gil Akos: . . . The collection of thesis studios typically have an umbrella under which the students are developing individual research projects and design projects. There are upper level seminars, and those are all formal means of integrating technology into the curriculum. And then there is, of course, the informal means like workshops, be it student- or instructor-led, within the confines of the school. And to a certain degree, Pratt has this – and I think it's maybe a little more visible elsewhere – digital presence, like a web presence that might be particularly for distributing knowledge within that institute or university. Again, that will be classified as semiformal because it has to have a kind of face to it on the web, but it also can be informal in the kind of process by which people that engage that entity exchange information.

Interviewer: I remember at one of the architectural juries at Pratt . . . the studio project or assignment was apparently to create a unit, trying to manipulate that unit to interact with one another, and then multiply that unit/s to create a structure or a system. So is that an assignment or a project that is done every year?

Gil Akos: I guess to preface my comment, for the last four and a half years or so I've been teaching in the undergraduate department. From what I know of the kind of core curriculum, there are exercises like that that happen at a material level . . . I think this happens in second-year studios, and I think that that is a useful kind of assignment to engage technology. Like, the distribution of elements in spaces is something that computational tools do very well. But I don't know that that is [a] prescribed assignment in the design studios.

But, I guess if I were to elaborate in terms of how digital technology might be integrated at a more micro level as opposed to curricula level, I think that there again the program is huge, so there's lots of different ways to do it. But one way that I know that we do it is by creating assignments that foreground direct engagement with the process, and in doing so, something that is complex like simulation or digital fabrication – something that might be new to a student or maybe it may seem complicated – can actually be broken down and understood at a very direct level. And that I think is a very interesting way to go about integrating technology into curriculum because it allows a kind of threshold by which a student can engage and evaluate at a very simple level, or analyz[e] a particular portion of an object or a process so that can be then be deployed so that what is created happens to end up being complex is understood in fact through simple inputs that cause that complexity.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

Gil Akos: I'd probably say always . . . I think, [that] came more from a practice-based knowledge than let's say academic-based knowledge. So, not to say that our Practice (with a capital P) is what did that, but more that I mean doing something and engaging it with both the hands and acknowledge[ing] certain connections and be[ing] critical of that technology in the first place – let's say digital technology – so that when there is a significant connection between those things, then one can understand digital technology and analog technology as being part and parcel of the same spectrum of media through which you design. So in that way, like, my view on technology is inclusive of doing the things that we've, Ronnie Parsons and I both, learned before we were really fully engaged with the computer back in school in the olden days.

Like, when we used ink on Mylar and that kind of thing – and that is a technology also that exists within the array of things that you might use to work through a design product/project. But to be more specific, I think my understanding of that has been catalyzed by the practice that we started, MODELAB, that's now four years old and had its roots in my studies at Columbia University with professors like Edward Keller and things like that.

Interviewer: What do you think are the positive and negative implications of this?

Gil Akos: Well, I think one potential negative implication of using digital technology is allowing the abstract nature of that technology, for lack of a better term, [to] get in the way of a fluid design process, looking for – when you're using the computer one way that makes it different from using a pen – the kind of feedback that one gets immediately from the pen or let's say sculpting something, there's a direct feedback. You may be using tools; like in the case of a sculptor, you may be using a chisel. So that is an artifact of technology, but it's a little bit more direct, whereas let's say with digital technology there is at least one level of abstraction between the thing that you're designing and the kind of engagement that you have with it as a designer. So that would be one of the main reasons why I've liked to approach teaching the way I do, same as Ronnie Parsons, so that there are less boundaries or layers, let's say, between you and the thing that you're creating.

The positive aspect of this is that abstraction allows one to set up systems that would get you to a place far more unexpected. If you're sculpting a piece of marble, now there's a certain degree of unexpected things that might happen, but it maybe has to do with kind of the imprecision of your tool and richness of the material as you go through it. Whereas with some computational techniques employed with the design process, you can arrive upon wholly unexpected results. So you've discovered many things along the way, and it's not because of imprecision but most likely it's going to be because of precision.

Interviewer: How do you believe technological models shaped architectural pedagogy historically? The critical thinking when teaching design and architecture?

Gil Akos: Well, I think that there has to be a direct link between technology and pedagogy over time like going very, very far back, even [to] those art schools and beyond, even before the Crystal Palace, when things seemed to be contemporary in terms of materials or construction processes. There's always stonemasons and the tools by which they created the elements that composed gothic cathedrals. Now it wasn't in any kind of proper pedagogical model that those were employed, but the guilds were essentially a specialized university that maintained distributed knowledge as NASAD. So I mean, yes, they exactly did, and I think that there, historically, has to have been a reciprocity between advances and practice and how that had been distributed as a form of knowledge within, let's say, the institution.

. . . We were saying something about [how] advances of digital technology seem to be more frequent and more accessible to students and academics. So very high level programs can be put towards the development of academic projects and research, but I think that reinforces even more so the fact that applied workflows become more necessary to understand the implications of that technology relative to design. So if we are to step back to what we were saying before about pedagogy and practice, I think that, historically, practice leads pedagogy in the use of technology, and that places more of an emphasis on us as academics finding ways to investigate that technology through applied means and kind of register what kind of significance that might have as opposed to have experimentation for experimentation's sake.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? How?

Gil Akos: I guess, my personal opinion would be that access to technology and access to learning the technology is going to become more and more widespread, so it's going to be more distributed . . . Not where it's the kind of ideal scenario of finding a situation where everyone knows everything or anything like that, but just that it's going to become more distributive. So how one engages that technology can be then understood to exist within this kind of gradient of how they also engage the collective outside of themselves. So I would imagine that the ways in which people collaborate would become more and more fluid, and in that way, I guess the question of authorship is a little bit at play within that scenario.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the keys issues that you see arising?

Gil Akos: I think that in architectural pedagogy, let's say – because that's we're talking about, right? – that there will not be any one paradigm that wins out. I'd say that the general trend would be that the use of those as conceptual devices, those paradigms, would become more diverse and integrated. So systems theory will be hybridized with information theory; even though they seem discrete, I would imagine that they become more integrated.

Interviewer: And what are the major/key issues that you see arising?

Gil Akos: I would imagine that the kind of widespread definitions of those paradigms would have to evolve. I'd have a hard time seeing that one – if that were the case that these paradigms were going to become more implicated – that one would be able to maintain a theoretical position that is exclusive of that. So, I think that means that there would be some pretty interesting conversations that would emerge. I think that this is already starting to happen anyway in terms of people that are getting together at symposiums and conferences these days. I think there are starting to become really interesting debates and conversations that have come from it.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

Gil Akos: Social culture in the architectural design studio – I guess that my observation would be that . . . the exchange of information across students' projects and student-to-professor is becoming much more fluid. And maybe one challenge is that could mean it becomes less formal, but that I think is kind of a secondary challenge – more importantly, that the project or the mind of investigation can be more loose in terms of how it gets to where it's going because of the fact that students and their professors are able to communicate and then share resources and [because] means of approaching that technology are easier. So I'd say that it becomes more of one finds himself within a collection of designers as opposed to producing their projects on their own.

Interviewer: Providing blogs, tutorials, and discussions online – did that change the way that the students interact with each other and you?

Gil Akos: In our generation, when we were in school we had to self-teach a lot of stuff, and that kind of information wasn't available widely. So most of the knowledge was still a result of exchange from faculty or TA to the students and banding together across students and figuring things out. But that process now involves more players; some are web entities, and some are physical people. So thesis students might be interested in one particular means of production or technology and might ask the person sitting next to them who might then direct them to an online resource. So, in a lot of ways I think that – relative to the cultural and social implications of that – students don't have to rely upon a kind of linear timeframe or a kind of capture of knowledge and then production in a kind of standard pedagogical method, but can go eight steps further and four steps back and then take a right and then end up maybe at the same place, but also very, very quickly. So you can accelerate a very proficient knowledge and not necessarily a specialized knowledge in a very short amount of time. So the end goal is that you can talk more about design issues than technology, which is, I think, a very interesting development.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Gil Akos: I think it's all of those things. I think that those things maybe existed before contemporary times and before the contemporary paradigm of digital technology in the age of information, but it seems like they are unable to buy the current paradigm. So things can happen much faster, and I don't think that necessarily it generates any new modes of organizations. I think it can make ambitions of the project more diverse and the process much more fluid in that maybe team-based designs and agile organizations are more present, more frequent now because they're able to communicate and to exchange portions of projects so readily and strategies for developing those projects.

In the studios, it's almost always team organized, at least to group-based work, because I do think in practice there is a lot more of that.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Gil Akos: I would say positively, although I think it requires more responsibility of the students because, if things are more fluid and fast-paced, it requires one to be more rigorous about their design process and their research so that what is produced – that can be done so readily and quickly or shared so readily and quickly – has still a kind of critical understanding of its production. If not, it's just production for production's sake. And there's a lot of stuff they would not look at in a situation like that, but its location within the world might be challenging for that team or particular individual to enunciate.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years, the influence of technology in the design studio?

Gil Akos: I'd be hesitant to say in the future that there will be any kind of technological advancements in particular. I think that there are applications – web-based, software-based, or otherwise – that are more accessible, like project management software. Now it's like cloud-based and everything, which seems to be a general trend, that things are located on the cloud as opposed to exchanged across peer-to-peer computers. But I think that generally it will just be that there are more – I would assume there would be more tools by which one would be able to exchange information across the design studio, I think, in the world and in the studio class. I mean, I think that it just trickles down into the studio.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Gil Akos: Yes, absolutely. I'd say that that could be done in a number of ways, and I think that just about any project or assignment has to have multiple means by which that is done. So, for instance, if a student is introduced to a new technique, the first phase might be, "Okay, we will see what that technique can do." But then the second phase may be to what ends? Where is this useful within the design process, and how might it help me rethink exactly what it is that I'm producing?

So if you're talking about simulation, the first thing that I do with my students is actually do a physical simulation in the world so they can understand how forces are moving through material and what constraints are allowing or disallowing that thing to interact with the pressures put upon it and then take that exact same setup, same measurements, et cetera into a CAD environment and a simulation software to reproduce that thing virtually. So at the beginning, there's at least a one-to-one correspondence, and I think the same could be said for any kind of technique that one is employing – if it's parametric, or scripting, or whatever – that at first there is going to be a point where you need to know what the inputs are and what the outputs are going to be, which is just a primary definition that an algorithm or any process by which you have input makes change to output. So if one can engage that and use it first to do something, at least, maybe it's even reproducing something else, something they've seen or something they've physically interacted with.

Then the subsequent step can be, "Okay, well, if I changed these inputs in the physical world, I won't get the same results," or, "If I change these inputs in a virtual world, my script is not going to spit out the same thing as when I was trying to reproduce some sexy image I saw." Then that way, because you're changing the inputs, you automatically have to critically engage the result. It's now no longer just a one-to-one thing; I have to figure out why it's better – this one is better than that one – so you have to then be working with an evaluative criteria. So, I think, even if it's just sensibility or a formal issue that I like this one better than that one, that still has underlying reasons by which you're going to be able to acknowledge that product critically one way or the other or within a spectrum of possibilities.

Interviewer: Do you also assign some readings? And what are the topics?

Gil Akos: Yes, absolutely. I think that one of the fastest ways for most people to learn is through doing, and in that way, a lot of times the way I'll structure, let's say, weekly assignments or something is to first do something, evaluate what you've done, and then go do a reading, which would be a way for you to add perspective to the process that you've already undertaken. And maybe that causes you to rethink entirely and do it again. So I definitely think that understanding the broader context by which your research or your design project exists is extremely important.

Interviewer: What kind of readings? What are some of the topics?

Gil Akos: So, a lot of the topics would be about practice-based research. So, how one can investigate and gain a kind of design intelligence through that iterative thought and action process? And other ones have to do with the kind of nature of technology relative to culture: Frei Otto Institute for Lightweight Structures journals to something that's even a little bit older of a reference in terms of the relationship of culture and technology, like Lewis Mumford and the kind of intellectual progeny of those authors and how maybe even in a more contemporary light, through some of the writings like Lars Spuybroek, we might understand the work of Frei Otto in a better way. So those are some of the ones that are kind of on the top of the readings list, I think.

Interviewer: Do you give these readings after the design project or—?

Gil Akos: Oh, no, no . . . I was describing design processes as my observation of them being very fluid. So I think it's almost like if you're not rigorous, it can be frantic or frenetic collection of activities, but if you're pushing forward, I think that reading and doing and drawing and sketching and thinking and all those things kind of are parallel trajectories that overlap and tie into knots and move around, have lots of different connections with processes. And I think that's all kind of a collection of things that one does within a design process.

Interviewer: Do you teach students to push back on and innovate beyond these paradigms? How so?

Gil Akos: Absolutely. And I think one thing that I tend to stress with my students is that certain applications, let's say, are very good for certain things, and you may run against one of those limits very quickly or you may not, or you may find a way to creatively engage in those limits, which I think is also interesting. I mean, that's innovation, right? Finding a limit and letting that rethink your approach to the problem in the first place. So I think that the way that Ronnie and I both structure our weekly assignments tends to push the students to find that problem without telling them that that problem existed and then find out how they respond to it. Do they completely tack right from the trajectory and go a completely different way, or do they say, "Well, now that I understand that is an issue, I go back to my first set of inputs and modify them in this way – I might be able to actually have this influence something within that domain of constraints."

Interviewer: Do students think critically about how these technologies affect architectural representation?

Gil Akos: I think they do. I think that whether or not they can verbalize that might be a different story, but I'd like to think that the way that we structure our courses instigates critical thought to begin with. I guess, my experience, that's mostly just about trying to process and then verbalize that set of observations. I think that it takes time for me to process those things. So, one of my professors when I was in school – when I started the first day, I was freaking out because it seemed like so much – but he told me subsequently after letting me try and fail in a bunch of things that the curriculum was not intended for three months, but for three years, because you can really only understand a lot of elements of contemporary technology and their implications over that amount of time and trial and failure. So I think that if I have a student for three months, hopefully the beginnings of some really interesting critical thoughts will have been solidified by that point, and I think that it just takes a little bit of time for them to start to be able to articulate that.

Interviewer: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Gil Akos: Well, I mean, I think an obvious one is that it enables efficiencies and effectiveness within the design process and the projects that come from those design processes. So, of course things are going to be just by nature; that's already a demand in the marketplace for things to be more efficient or more eco-friendly, right? I don't think it necessarily needs to be explicitly stated that you need to be efficient. If one is engaging in technology critically, as we were just saying, and us[ing] it as a way to think and do, then I think it would be natural for them to be able to employ that same thing. So I think that so long as the kind of pedagogical approach to social responsibility is a robust one and not explicitly stated to be overtly so – does that make sense? I think that that's kind of allowed the students to really flourish and not have any problems with that and be, in terms of design in practice, very responsible. So I think I see that happening at the school.

Interviewer: How might this definition of social responsibility evolve in the future in relation to technological advancements?

Gil Akos: I can say I've a hard time seeing exactly how – if they're being socially responsible now and conscious of the changes in culture since architecture is a method of cultural production – then in practice they're going to be able to evolve. I think that maybe preparing students to be more socially responsible in the future might actually mean having them understand the kind of cultural pressures that exist within the architectural realm. So, as long as they understand what it means to be socially responsible and they understand the kind of pressures that are at play, then when those pressures change, they can adapt and evolve to meet those demands.

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Gil Akos: What percentage? I'd say a lot, even if they're not necessarily that familiar. I mean, I think even if they're teaching, it really seems like that question could be related to a five-year program or around the fourth semester studio because there's a lot of schools where the computer isn't necessarily taught until then and maybe even later. But I think that – even if a lot of our colleagues don't use advanced digital technologies on a daily basis in their own practice or their own research – I think that it becomes something that they look for their students to do.

So a couple examples: those faculty might see there's an interesting thing to pursue for their studios and therefore they team up with people that are very fluent with those technologies and that can be seen often in thesis-level studios because faculty that may have been teaching those things for a while, I think they are interested in – the most successful scenario might be where they engage another faculty member to co-teach with them and in that way there can be two interesting but maybe diverse voices on the top. Sometimes it might take someone who is not kind of intimately engaging software on a daily basis to elucidate some really interesting observations about its use or the results of that use of that technology. I could also see where the daily use of it might also allow you to have that singularly of interesting observations. So I'd say that most [use digital technologies] – probably 70%, I guess, if I were to put an estimate on the number.

Interviewer: How about the 30%? What are the primary factors that you believe may hold back those faculty members who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

Gil Akos: It might be as simple as exposure to those things, to those technologies in an intimate fashion. I mean, as I was saying before, the more advanced the digital technology is, the more it relies upon abstraction. And the charcoal on paper and ink on vellum, those things provide – the only abstraction is the fact that we are representing something else. And that's something that architecture's history has – or architecture's long history dealt with, right? We are representers of things. So, beyond that level of abstraction, if one didn't understand those advanced technologies – they rely upon more and more levels of abstraction and how one might engage that specificity or lack of specificity in the process – then [they] could be intimidating, I'm not saying they are intimidated, but it might be a reason to be critical of it, which I think is completely valid.

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation? How?

Gil Akos: Yes . . . I think the faculty members think critically about how the projects that the students are producing are represented and what they are representing. I think that one particular observation that some of my colleagues might have and have brought up in their studios is how a kind of precision and complexity of relationships might actually be represented in a very, very clear fashion because of the tools and technology so that scales of time or dimension might be less of a factor inhibiting us from representing some relationship presence and even potentially an opportunity to do so.

So, for instance, Michael Chen and Jason Lee have a studio called Crisis Fronts. This is a thesis studio they've been running for five years now, and that's one of the very specific agendas of that studio. You know, they might engage a design issue of the scale of a region as opposed to a site, like all you can say is the region is the site and really only because of the capacity of their students to engage technology in a very high and critical level – that's the only reason why they can really assess particular relationships that they can then redeploy within the context of maybe a more specific design intervention. And there's many more ways that faculty are critical of technologies, and they may be more or less interesting. It's a very specific one.

Interviewer: What are the opportunities these technologies offer? What is lost by their use?

Gil Akos: I think what may be lost is the kind of understanding of that virtual medium as being specific. A parametric design is that if you're defining a solutions base of multiple variants that can arise from change in the inputs, then the particular elements, that is, the final version might be just understood as having less significance for that. It doesn't have significance relative to being better or worse than another. In that way, the thing that is very interesting is that parametric design can be kind of crushed in the fact that what we can define is a family of solutions where a lot of them might be equally fit in terms of analytical information, but that doesn't necessarily mean that any of them aren't the best. So I think that that suggests – or the one kind of potential loss in design process is commitment to a particular portion of design – or, in kind of the same vein, loss of rigor about how a project progresses so that it's not just a loose thing, but you actually can in the process commit to things for a particular reason and move forward from there.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Gil Akos: I'm sure that they have. Do you mean broad economic concerns in the world, or maybe you're specifically vague in that sense? I'd say that in terms of the students becoming practicing architects, that definitely is a concern, and certain things are expected of a graduate of a professional architectural degree at this point in time. A lot of them, like, things that professionally are in vogue, like BIM – those things are something that the school tries to integrate into comprehensive studio and more seminars so that the students can be tooled up in that design technology so that they can successfully practice in the world, but I think also kind of how, at a maybe broader level, how decision-making about the configuration and material choices, a degree to which constraints are used in that process or not at a larger scale within the design project are definitely also a part of it. Comprehensive design studios also are an interesting place to investigate relative to that question because, you know, if you are having to design [a] façade, some very small, seemingly small decisions that you make can have very large implications relative to a budget and maintaining a budget. So now it has to go back to practice, increasingly more and more a part of the studio culture at that.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Gil Akos: I'm not sure how to put this relative to ethic, but I think the best practices of the use of technology are an important thing to understand and I guess relative to professionalism. I think understanding what technology is and how to think through technology can translate into ethical concerns as much as technical concerns, and I guess if it's about producing students that are ready to be professionals and act in a professional manner, yes, they have to. Those kind of concerns definitely affect how they chose to apply technology to their curriculum, but I guess my answer is pretty general.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Gil Akos: I guess, like we were saying before, things are more accessible, and the means by which you can learn them are also more accessible. And if the pace of studio and the workplace are accelerating, then one challenge is how one is critical of the things they produce in a short amount of time. So I think that being able to slow certain things down so that one can engage things critically is important. So I guess I feel like going back to a lot of the things that we already talked about relative to, let's say, our understanding of how one might slow things down or kind of focus on relationships that allow for critical thought.

I guess the pressing concerns would be, if the condition is that things are superfast and fluid, how high portion projects or process [assign] value and [understand] what's at stake. So that the thing doesn't exist in a vacuum because if you get swept up in a process that's superfast as a student, you may be on the kind of fast track without having been given the opportunity to, or rigor to, decide what is available and what is that value related to in the broader sense. So I don't know that it's inherent the use of technology. It's kind of hard, in fact, the criticism that there is a loss of criticality, but maybe just pace and evaluation. So I think that that will be the biggest thing to me is: how do you evaluate any design version and how do you also say, "This is really important that it's undertaken in this manner"?

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Gil Akos: I don't think so. I mean, I guess one thing that we talked about how using advanced technologies can afford you an opportunity to discover things along the way and amend it enough in that way. I also think that within that spectrum of technology, there is an interesting conversation to be had about how one gains intuition in terms of their design process and application of technology such that some of these other elements of the conversation we had just had – being critical, being critical in general of your process and production. So I think that conversation is an interesting one, but I think it could be had and maybe could be had more frequently because I think that it suggests that without having to be a kind of technophile or specialist, you can really engage and utilize technology in a wide ranging set of ways so that it doesn't have to be – I guess that technology as a really broad topic – it doesn't have to be thought of as separate from any other way of approaching a design issue so that, in that way, it's really inclusive because if you can gain intuition about design through the use of ink on Mylar or you can do that through writing code, I think it really allows you to engage a lot of broader topics beyond the kind of specifics of how the ink comes off from the tip of that pen or how that code is practically structured. So that – there's a lot of opportunity there to have a conversation about technology that is more expansive than only the use of the computer or only the use of CNC technology or anything like that.

Interviewer: Thank you, Gil, for your help.

Gil Akos: You're welcome.

8) Greg Lynn

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school (UCLA)?

Greg Lynn: Yes, I begin with techniques and concepts in my office and research and then bring them into the university as pedagogy very directly to see what the scope and implications are and then afterwards publish and exhibit the resulting concepts and results.

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school?

Greg Lynn: UCLA was the first school to look at fabrication using CNC machines and to integrate these digital methods into the design studios and technology seminars. This is now a common pedagogy at Yale and the angewandte Wien, where I currently teach, and it is also a method I brought to the ETH in Zürich when I began teaching there almost 15 years ago.

I believe methods of fabrication using digital files and digitally controlled machines is a common preoccupation at many universities around the world now; it is perhaps standard. BIM and parametric design apart from fabrication is also a more vocational concern and is being integrated into the curriculum of many schools. Now I am moving on to movement, where at UCLA we are setting up a lab dedicated to moving buildings. That is literal motion.

Interviewer: How are they integrated into the curriculum?

Greg Lynn: In the studios and in special technology seminars that are run like mini-studios. We also work with external partners like Disney Imagineering and Cirque to see how they use the technology.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (e.g., professor, administrator, student)?

Greg Lynn: Over 20 years. And they were methods and pedagogy that I brought to the schools at Columbia University, Ohio State University, UCLA, Yale, ETHZ, and the angewandte.

Interviewer: What do you think are the positive and negative implications of this?

Greg Lynn: [The architectural program] can become vocational training rather than design when it is seen as a science rather than a medium. It also makes designers into amateurs, and studios are often using the crutch of experimental digital design to mask that they are not expert in their use of the technology. I became very tired and frustrated by the experiments in form-finding in the '90s that still somewhat continues today in some places.

Interviewer: How do you believe technological models shaped architectural pedagogy historically?

Greg Lynn: Stylistically, formally, and in terms of construction. It also nearly eliminated architectural theory because the theorists and historians were and are incapable of talking about digital media beyond the jingoistic futurists of the '90s who promised liquid space, etc. And the designers were either unable or not interested in theoretical and conceptual reflection so at this time the field has never been as critically deficient as it is presently. The museums and curators are also more depleted conceptually than they have been in history, perhaps, so the critical community is in big trouble. Same goes for journalism as if – you track the critics for the N.Y. Times, for example, from Muschamp and Ourousoff to Kimmelman – you see the de-professionalism and lack of working knowledge of the field that is presently acceptable.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? How?

Greg Lynn: Yes, smart people will begin critical thinking and writing again, and hopefully some form of conferences and publications will re-emerge in architecture again.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the keys issues that you see arising?

Greg Lynn: Most likely technology will be adopted by construction managers and developers first as is occurring now, and the architects will become further marginalized in the building process. I imagine that figures capable of cultural discourse as well as technical innovation will become more important in the field as the general strength continues to diminish as other parties take on responsibility and knowledge. Hopefully in the near future, the situation will return to what it was maybe 100 years ago where the knowledge of materials, means, and methods of construction will become the role of the builders, and the architects will produce the documents needed to define design intent but not be the surrogates for the construction process, whose main role is the conduit for litigation.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and

their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

Greg Lynn: Most graduate students have websites, blogs, and virtual offices and identities by the time they graduate and have less patience for long apprenticeships in offices to gain knowledge and notoriety.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies? Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Greg Lynn: Most of my students do not use books or the library, and so they are not well informed about anything that is not on the internet. Because the internet is populated by recent press releases and publications and not historic information, it means that history begins in the ’90s for most graduate students.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Greg Lynn: Loss of deep disciplinary knowledge.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Greg Lynn: Yes. I do not teach vocationally and assume they learn software somewhere else.

Interviewer: Do students think critically about how these technologies affect architectural representation?

Greg Lynn: I don’t really focus that much on presentation techniques.

Interviewer: How might . . . responsibility evolve in the future in relation to technological advancements?

Greg Lynn: Being cultural leaders involves being aware of the effects and trends in technology.

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Greg Lynn: Almost all.

Interviewer: What are the primary factors that you believe may hold back those faculty members who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

Greg Lynn: Lack of intellectual curiosity.

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation?

Greg Lynn: Yes, probably first response before they move on to more profound implications.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Greg Lynn: Partnerships with external entities beyond university walls are primarily based on technology initiatives, so no big problem there.

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Greg Lynn: No.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Greg Lynn: There was an anonymous website campaign against faculty led by faculty and students a decade ago, and the university was ill equipped to handle the situation. Intellectual property issues are also very problematic and not resolved yet as far as recording and using materials developed by faculty for specific courses that are then posted and monetized by the university without permission or copyright.

9) Jason Griffiths

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at Herberger Institute for Design and the Arts, Arizona State University?

Jason Griffiths: Yes, it does. I would say yes. I can get into more detail with that.

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at Herberger Institute for Design and the Arts, Arizona State University?

Jason Griffiths: Well, I mean the usual ones, really, so far, although I think that it's changing, developing. So we, like any another school, try to push parametric design, obviously, and I think we are ahead of the game on fabrication issues. I think in other parts of the school, I suppose in the last three or four years, there are members of faculty who have come in who have approached it from more of a theoretical position, or approached design wholly from a position of digital design, digital technology, different methods of digital design. So I think that that's new. I think we are looking at a new specialized character within the education system, whose main direction, main concentration, would be in digital design. I think, in fact, two or three, perhaps four, people come [to mind] in that respect – obviously technologically, or technically more advanced, more savvy in terms of computational techniques, but also some from more of a theoretical direction as well. And I think that's the area that we are approaching it in a much more proactive manner. Of course, digital design does shape the school, whether we are doing it in a kind of a passive way or whether we are doing it in a sort of a proactive manner. Whether we are discussing it in terms of its effect on pedagogically, which is what we are doing here, I suppose.

Interviewer: Is there a specific theory that drives the use of technology or the involvement of technology in your studios?

Jason Griffiths: In mine, yes, there is really. Would I call it a theory? I suppose – I would say that I do approach it from a theoretical angle, although I would say that it's different from the way in which most schools consider it to be theoretical. I am much more interested in the way in which technology reflects upon, deals with very commonplace issues . . . I am interested in the ideas of how, let me just put it in a good way, characterized by influences that are external to it and how in some sense how it's distorted by those external influences. So really my approach to it is a very day-to-day approach.

We can analyze the word day-to-day – or quotidian, if you like, or orthodox – the everyday in terms of different facets of that as an idea. But I think I can, from that angle – as opposed to the way in which I think that it's been adopted by many architecture schools, which is really to do with the idea that it's part and parcel of a partly biological system, quasi-naturalistic system to do with developing mathematical models that were developed in nature in different ways, all of which I think is fascinating and serve to inform the discipline. My view on it is slightly different from that. I am taking that as a point of departure from my involvement, but I would say I am doing that in a way in which it would assimilate past interest in critical theory, I suppose, in architecture and looking at how then one hybridizes that against the advent of digital technologies. And that is not necessarily – I wouldn't say I am deterministic about it. Certainly not. I am more interested in the way that technology causes problems as well as facilitates things. It's not just about optimization and the idea that technology will make things better, not necessarily.

Interviewer: Some professors at ASU said the school adopted the general systems theory. Do you agree with that or do you think it's more than that—?

Jason Griffiths: Systems theory.

Interviewer: —because the focus is on the unit and its relation to the whole. And from the unit, which is more important than the whole, we create the structure, the whole. So there is that systems theory paradigm. Other schools say it's a mix of everything.

Jason Griffiths: Yes, of course. For me systems theory is absolutely off the agenda in terms of the way in which it has been traditionally deployed in architecture schools. And I say that because I think one can demonstrate how systems theory in other disciplines outside architecture has been completely counter-productive. And you only have to look at the way in which the banking system has worked, read the implication. The covert implication of systems theory is this – my interpretation of it is that the assumption [is that] systems will naturally stabilize themselves, and repeatedly we see things to the contrary. I'm much more interested in entropy than systems theory. How one system invariably breaks down and doesn't self-stabilize. For me, it's a very lazy and very politically loaded statement, systems theory. I think it's a way in which one uses technology to wrest control away from the individual in my view.

Interviewer: How are they integrated into their curriculum? I mean the technological paradigm or what classes...

Jason Griffiths: Well, for one thing, it's absolutely imperative that all students are aware of what's available; that's one issue. But it's our responsibility as educationists [to be familiar] with what's going in the world outside architecture . . . We have to foster a positive critical debate about the role of technology in architectural design, and in order to do that, we have to think about what it means to debate something, or think – or develop techniques to debate things and develop methods of being critical. And in order to be critical one needs to analyze things. You need to be historically aware, obviously. But we also need to prevent ourselves from . . . be[ing] encamped in different ways technologically . . .

We’re using those methods to design and discuss things which are particular to the context that we find ourselves in in Arizona as well. I think that’s one thing that separates us from most of the other schools because our environment is unique. So that’s one issue. What I’m interested in is overcoming this kind of horrendously modularized or compartmentalized system that we find not just in America, but in developing education systems, so students understand how to . . . take a discipline and work it into design as opposed to having or being taught things in a compartmentalized manner. So really I run my studios, my fabrication studios, in parallel with one another. I try and get as many students on both of them so that they’re learning something and they’re also discussing it. They’re using judgment in order to apply it to design; thus they are giving it some level of – I don’t want to use the word pragmatism because that sounds retroactive – but I’m using it in different ways that will allow them to understand how it affects people outside the discipline of design, outside school, through the built project in one way or another.

Interviewer: Does the school provide any theory classes related to digital technology use in architecture and design?

Jason Griffiths: No, it doesn’t, actually. I think that it’s implied; the theory is implied in some of the classes, but we don’t really teach theory. I mean, I’ve done [a] certain amount of pedagogical analysis on teaching digital design, but that’s never really been included within the school in the way in which other schools do it. And I think there’s an apprehension about it. And again, I think rightfully so. I mean, if you look, there’s a whole stream of schools now that are reading the same books, and it’s kind of hegemony of certain theories which have been called into digital design [don’t] really belong there, wholly in my view, whereas I say there’s a healthy reaction against it here. I think we have a very positive alternative.

Interviewer: What do you think are the positive and the negative implications of this involvement of the technological paradigm in pedagogy?

Jason Griffiths: I start with the negative ones – I’m really concerned that it de-socializes design in its worst form. Or it de-socializes communication. That’s not to say within design, but I think what the computer allows one to do in a completely immersive environment is to not only separate yourself from what is the design, but the social structure that is design. I’m not talking about social structure that’s, let’s say, fraternity if you like. I don’t know the right word. If we described it in terms of aspirations of someone like William Morris, where the social component is very, very carefully discussed in terms of both every player within the design process, then I don’t think digital design has replaced that. I think it’s alienated us further in that respect or has the potential to do so. And the other issue is the alienation of the individual student as well. We are ethically responsible, I guess, in some way in terms of what we’re asking students to do and the implication of what they do.

But some people argue that spending [a] vast amount of time on the computer makes people depressed. There's a lot of theory behind that as well. Physically, the environment is very good. In terms of gender issues, I think it's diabolical, you know. It's all guys, you know, and one has to look at them very, very carefully. So those things really concern me a great deal. In terms of its positive benefits, I see a vast amount of benefit when it comes to communication, speeding up the communication design methods, issues of being able to see versioning, mass customization, all that kind of stuff. But the danger, of course, is that the iterative process becomes a sort of quasi-critical form; that is, one can repeat things endlessly in a way that is sort of meaningless. So that is negative, but one sees it in a positive way if students develop ways in which they input information that relates to the world outside. Computers understand there's a set of constraints. It's [an] amazingly powerful and persuasive and convincing tool, I think, just in terms of production. Production of information for the sake of itself is sort of problematic, you know. I see a lot of iterations just for the sake of it.

Interviewer: How do you believe technological models shape critical thinking in architectural pedagogy historically?

Jason Griffiths: There are periods of technological advancement and then a kind of a relapse and then the advance. The reasons for the things advancing aren't always positive, you know. And, they tend to hasten. I mean, wars tend to hasten technological development . . .I want to question the notion that . . . technological development is not always a positive thing. It may or may not be a positive thing. Historically, with the advent of a piece of technology there tends to be a lot of enthusiasm around [it], and then it will filter its way down into what is the wider discipline of architecture and find its use and find its role.

So, obviously, different methods of drafting and production affect methods of design as well. You can equate linear to the use of parallel motion to modernity, the clean lines of modernity. As much as you can say that the post-war interest in thoroughly curved surfaces really came out of – was pushed through the automobile industry and aeronautics as well. But let's not assume that it's always positive. One would argue that the heavy, most primitive brutalist architecture of post-war was a reaction against certain form – one would think Le Corbusier reacted really against the notion of a white hot technological architecture because he saw what Second World War technology had done, destruction in the Second World War. So it was a stance. It was a piece of reaction against technology, to return to a very primitive method of building. And so I think that historically it's very difficult to put it in a linear progression. But we're certainly in a boom phase now, coming towards the end of a boom phase in terms of technological development.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? And how do you see that?

Jason Griffiths: How do I see it? I'm not sure what relationship I'm talking about really here. In terms of—?

Interviewer: Involvement of technological paradigms within pedagogy.

Jason Griffiths: Yeah, how I, well—

Interviewer: We passed the mass production then the mass customization to the information era. What's next, do you think?

Jason Griffiths: Yeah. It's a very good question. You know, if I knew the answer to it, I'd be prophetic, but it's simply impossible for me to suggest partly because my view is that it will be romanticized in a certain way. I don't mean that in a negative way. Let's say not romanticized, maybe, but the expression – using architecture as a means to express technology in its own right is not enough, I don't think. Or using architecture to demonstrate an absolute level of capability in itself is not enough. Simply because whatever it is that one understands in terms of the complexities and the ambiguities of daily life, those things need, in my view, to be present in architecture. Those imperfections that are brought upon it by one's natural, let's say, what was it – somebody said the opposite of artificial intelligence is natural stupidity.

You know . . . I think the public or, I'd say, that the recipient of architecture is intuitively savvy towards things that come from a monocultural, strictly technological background. We don't give that response enough credence when it has a super hyper sophistry to architecture. So, and I think, periodically, architects have gained a great deal by dealing with formal development in a mannerist manner, but a mannered form or a romantic form as well. So I'm much more interested in the way in which these theories, the ideas of a system breaking down or the idea, the way in which it's complicated by the personal difference forming a kind of interruption to the notion of it being a perfect world. And I think it's much more – in a strange way, I find that more positive. If it's ironic or, let's say, critical in some way, the imperfections of technology I think are quite edifying for people, quite encouraging in a sense, in a weird way.

Interviewer: So you see the beauty of it?

Jason Griffiths: The beauty of it, absolutely. You have very little contemporary automobile design without custom cars. And of course, custom cars are a form of vernacular. Automobile design didn't really know where to go until you started having – god forbid I'm promoting – but things like the [P.T.] Cruiser and then all the retro versions of classic cars. For me, the designs of those, which are very savvy designers looking at custom cars, obviously have some historical value. Historicism of these things is extremely contemporary. So, I'm much more interested in it from that level, in terms of, let's say, the day-to-day popular taste, you know, what I would consider outside the profession.

Interviewer: Which technology or technological paradigms do you think will be

most influential in the coming years? What are the major keys issues that you see arising?

Jason Griffiths: Well, are we talking about the design process or are we describing architecture? So are we talking about the built environment?

Interviewer: In the design process.

Jason Griffiths: In the design process. Yeah, I think there's certainly a point where authorship becomes a completely different issue. We've had issues; we've had problems. I mean, the wonderful thing – essentially, I would still regard the computer as a very sophisticated collaging device. And, of course, when one collages, the content of what you are creating is really determined by the meaning of the fragments of that collage, before you start collaging them together, where they came from. I think, in the process of doing that and the way in which the sources of a collage can be – I'm not talking about necessarily cut and paste collage in the traditional modernist sense; I'm talking about a big collage of different saved spaces, materiality, association, of symbolism, all that kind of stuff. So for me, the real innovator is the person who understands the tool. The computer is a tool for carrying out that collaging very quickly. And also, those people that will push our understanding [are real innovators].

What the computer does is allow us to borrow things much more quickly, and of course, that brings up a question about plagiarization and where we sit architecturally. We see that in very clear examples of where somebody just copied something. When one uses it in a creative way, I really value that as a debate. I value that, and I think that's a really powerful, important debate. So for me, the most technological advances will exist where we see groupings of different forms of technology or design tools working for innovation. And those groupings may not have to do with what the computer companies tell us. If I get excellent file transfer between one piece of technology and another one, I think it's potentially much broader than that. The other issue is, again, what we would encourage is students to understand open source a little bit better and understand sharing. But again, I'm not quite sure whether we're at that stage yet. That might be an issue, question, to follow.

Interviewer: That brings up the issue of shared-authorship in a collaborative model. Nowadays in the process of designing some use scripting, maybe through an open source where a lot of people are sharing their script; some may take it and build on it, and some may just copy it.

Jason Griffiths: I subscribe to that a lot; I really enjoy that. But that issue of being collaborative is, I think, it's unique to our profession. I really became an architect because I was interested in many things. One could put that down to indecisiveness or procrastination. But we are allegedly experts on experts; I think that's what we need to be. So, when we talk about collaboration, it's very dangerous to say that it's all about everybody collaborating because that's not in the nature of certain disciplines. The word ‘collaborative’ is used in a much heavily loaded way at the moment. But I think it’s something that we’ve always done, and I think we have the means to do it more efficiently. But certainly, specialization is an interesting issue, I have to say.

Interviewer: Do you think because of the advanced technologies, we are reclaiming a territory or a field that’s been taken away from us? To be involved with the structural engineers, electronic engineers; we can do the site analysis using specific software to study the physical condition of that site. Or are you more with the team, cooperation work? Everyone is an expert in a field, and we get together.

Jason Griffiths: Oh, absolutely, if everybody’s doing it, absolutely. I don’t think it’s really as hierarchical as we would like to believe it is. Partly, the proof is that we have very little standing in the day-to-day deployment of our profession. All the things that you describe are means and methods, and that’s part of our conversation. Of course, my old teacher many years ago – called James Gowan, who’s in partnership with James Stirling – when he was confronted with one of the students who was developing a fly-through model just using Form-Z at that particular time – and everybody was amazed that this guy had managed to do a fly-through model – and his first question before he saw it was, “Are the spaces worth flying through?” You see, and it’s absolutely a fundamental question. It’s a fundamental question that it doesn’t really – the means and the methods of those things are really very temporal. The importance in profession is, one, to establish widespread dissemination publicly, and I think the computer can be used to do that. Methods of disseminating information are extremely effective in that way.

But also the issue of the permanence of architecture as well is something that I think we forget about, and in a sense that’s one of the things that we have above many other disciplines: permanence. Of course, recently it’s been pretty easy for architectural critics to use that terminology to imply that that’s a historically antiquated position, saying that architecture should be permanent. But what one fails to understand is that in radicalizing architecture towards impermanence, we actually are writing ourselves out of importance socially in broader terms. So, for me, I’m getting much more interested in the notion of permanence because that notion of permanence, how one achieves it, is what’s unique to the profession. Anyway, I’m getting a bit distracted from the central theme here.

Interviewer: On the influence of technology or technological paradigms on the social formation and culture of architectural schools, how are digital technologies and their associated paradigms changing the social structure or culture of the architecture design studio of your school?

Jason Griffiths: Well, we try to make it very much part of the first semester of the graduate program, of course, to get our students up to speed with that. So, are we talking about the social structure of students in a way that we might be talking about in terms of any course, or are we talking about it in terms of the way they understand themselves?

Interviewer: If you compare the design studio’s environment in the traditional

schools to what we have today, where technology and technological paradigms are proposed, do you see any change of the organization of that design studio?

Jason Griffiths: Absolutely. The social component of design schools usually occurs in and around discussions about the things that enable them to design. When I was studying it was sort of photocopying. And the print room was strangely the most important place. So the student's access to pieces of technology tend to be the core of social exchange, for better or for worse, because it's their life blood, it's their meat and drink. Any course is slightly different to architecture because it's always about – these are the 3D printers, you know, about sharing information in terms of software, the way in which things work. That's all part and parcel of social stuff. It's just the water fountain part of discussion, an analogy, if you like.

Interviewer: Do you see any changes in the discussion between you and the student, between the students and each other?

Jason Griffiths: Well, yes, I do, and in some ways, we've allowed ourselves to get into discussions that we shouldn't be. And a lot of my colleagues are really wondering how this breaks down in terms of teaching. But in the first few years, when we were trying to push computation and design in the first semester of the graduate program, what we were really doing was teaching software. And that became such a headache I can't begin to tell you what that was like, and we brought that upon ourselves. We were holding little software sessions in the studio.

Interviewer: In the studio?

Jason Griffiths: In the studio, and I think what we didn't do was discuss parametric design in analog terms. I think now we're able to do that, just to say parametric design is an idea as opposed to an idea that's associated with a piece of technology. Since you do that – you play into the hands of the software engineers, and they start determining the things that you do. So we're looking very carefully at the way in which we disseminate that information now or what we're asking students to do, investing their time in learning pieces of software. So again, it's an ethical issue. I think we've come to that now.

Interviewer: What social modes or organizations – for example, team-based design, hierarchical organization, agile organization, or even individual models – are enabled or disabled by the integration of these technologies in the class, in the studio?

Jason Griffiths: Well, we're trying to foster those connections, and I did that as much as I could in the way I was just teaching digital design even in the studio and trying to get students to cluster around different types of design and physical output. So maybe it was 3D printing, maybe it was laser cutting, it was bending, forming. And then to share that information so that they would work in groups and then have a kind of – have a platform they could use to start sharing their discussion. And, for me, enabling that kind of structure is very important to allow that kind of thing to happen. The way I went about it was by establishing forms and peer review sessions . . . I'm keen on doing that up to a point, and after a while, like all things – structure, and I say teaching structure – then becomes the content.

So it is necessary to break it down and make it more. Otherwise you're just form filling, I think. And that's rudimentary of, let's say, the science of teaching really as opposed to the art of teaching, which is more complicated in my view. But I still do some of the teaching. I'm teaching theory, conference sessions, things like that. So I'm trying to bring in some discussion. The other issue is – that we haven't really talked about – is the way in which the digital design would then connect disparate parts of the university, and obviously the fabrication lab and digital lab now are part and parcel of the same thing. And obviously, the methods of those two places are very different, and I welcome that kind of collaboration. It stops you seeing the world through the eyes of [the] computer solely and dealing with the materiality.

Interviewer: Do these technologies positively or negatively affect their interaction and learning within the design studio?

Jason Griffiths: I think it's positive on the whole. Absolutely, I do. But then when we're talking about interaction, we're talking about it the way of which is commonplace, really. The way in which we collaborate or communicate with one another is commonplace . . . We can have a discussion about it without offending each other and then use the computer in order to truncate the meaning of that conversation. This goes into a wider realm. This is the way in which we use the computer to say something we're too afraid to say to somebody face to face, let's say. The learning is much more efficient just to bite the bullet when it comes to learning really. And so, what I regret really, in a way, is that so much of the art of teaching is taken away from us when one can use— We could speak directly with somebody about something and to communicate something directly, and it's done as opposed to being able to go through the design process and then say something in an email subsequently which would be contradictory.

Interviewer: Do you create a blog for your class?

Jason Griffiths: Yeah, we use that a lot actually. And the good thing about the blog is you have a record of progress as well, and I think that's very useful for students. And they understand the trajectory of their design, and they can look at it sort of historically, if you like. So the blog is a really, really important powerful thing. But it shouldn't be used in a way to remove the microenvironment of the student from the process of design. That is, design is a process of reflection, of understanding the significance of things, and we do that contemplatively – that's the right word.

That's a sort of reflection. And, of course, the physicality of objects is hugely important and images around me. I'm in a quasi-architectural environment because it's on a computer screen. I'm in a digital environment. And what we're trying to do is transgress from a digital environment to the physical environment. So, really, successful work spaces for me are ones where they build up this sort of presence of odd bits and fragments and bits of physicality of architecture, and they use that as opposed to saying it has to be on the screen. It's actually a very small percentage of what we do in simulating something. It's the act of simulating architecture. I would say that also applies to 3D printing as well. It's always a 3D print in the end, formal; but it's limited, very limited.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years? I mean the social structure, the interaction—

Jason Griffiths: . . . It's those communicators who will survive architecturally, who will succeed architecturally. And I think that understanding your position in terms of a network of people and how you treat that network of people is changing quite radically. Just simply people are becoming more aware of different ways of communicating, but I think that those clients, whoever that is, or funding bodies, or various people are absolutely crucial in terms of getting buildings and things built – still operate in a much more traditional method of networking [with] one another. As that changes, as clients, younger clients come up, they'll be much more familiar with current methods of communication and networking, understanding where people are, that kind of stuff that puts the architect in a position of pre-eminence. So I think, in the role of finding a client, I think social networking could be [an] extraordinary way of understanding where you can do things and what you can do in inventing clients or discovering clients in that method. I'm sort of on the cusp.

Interviewer: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Jason Griffiths: . . . I think it happens on rare occasions, sometimes by accident. Let me give good examples of that. So the debate is usually students are critical of it when they're resisting being asked to do new things, and that's when they become critical; that's not the right form of criticism. And those students that engage in it tend to be critical in ways which are also not analytical. For me, the ability to criticize something should be part of history/theory that we do here. I think in some respects we do do that. Because it will allow us to reflect on, let's say, sort of proto-computational design methods that have existed in architecture historically or the history of this debate basically. Well, that prevents us from doing some of the same debates again. So, I hear the same debate about mass production architecturally. It gets renovated in terms of mass customization. Well, I say, here's the same debate that's against computational design with advancement of technology as well, which is – one might say it's become [a] craft-based kind of criticism.

And I think teaching about the history of that, the transition, the morphology of the role of technology. And architecture allows students to debate in a grown up way as opposed to sitting there saying the same things that had been going on for years and years. So how do you teach somebody to criticize something? I don't think you ever teach somebody to criticize something, I think, or to develop a critical stance on things. I think ultimately you put students in a position where they can do it, and they either do it or they don't do it. But I think to make basic critical evaluation for me is to – it's time for a critique about the effects of the way technology is deployed, and you need to understand it. There needs to be some sounding board, something to bounce those ideas off.

I think also, as part and parcel of that, the critical process is to combine pieces of technology or combine methodologies in a way just for the sake of doing it. Then you have this, really, this great opportunity to criticize something. Or you create something, or you make combinations of things that say to themselves – and then you accept or reject, quite often just reject whatever you come up with, putting disparate things together. So if I said I'm going to do a garden shed, but make it all out of diamonds, there [is] a whole set of reasons why one wouldn't want to do that. But in doing it, you can quite often discover things that you wouldn't discover unless you were attempting to connect disparate things. So, for me, that's where it lies, really, and I think students do that rarely . . .

Well, critical thinking is based on really not accepting the rules, per se, and doing things that demonstrate that they don't accept the rules. I think that's fundamental. I think the designer Vivienne Westwood would say that it's not only desirable, it is part and parcel of the designer's role to create things that cause objection, that people object to. It's only by doing that you discover stuff. If you accept the terms of a piece of software design, if you accept the rules about roof construction or, let's say, rules of development, you can't think critically. So, it's really predicated on being critical, on non-acceptance of the terms. Understand the terms and then reject, accept or reject. And that applies to computers as well, in my view.

Interviewer: If you have the power to add more classes or courses here at ASU to provoke this critical thinking, what will you add?

Jason Griffiths: No, I would probably have less, actually. For me the most important course is design. But the most important courses . . . demonstrate the connection between design and all the other courses. So, in my view, your dissertation should be written, your history theory component should be written on your project, where your design project sits in that realm. Your structure submission must be based on the building that you designed plus the sustainability. That's the idea; we bring all these things together.

But the education system allows students to pick and choose different things that they want, that would make their education unique and the buildings they design unique. So, in my view, you shouldn't be assessed in terms of structure and, certainly on a graduate level, in terms of how well you deal with a set of questions applied to that course. It should be how well you are building, or just as that in response to structural engineering. You won't get it right, but you'll understand it in terms of design. Really I would increase the importance – I think that design should be half of what students do, at least, if not more.

Interviewer: Don't you think it is too hard to put everything in the design studio course?

Jason Griffiths: But that's the realm of critical thinking. I mean, say, for example, I'm interested in depression era housing, right? Or post, or bust, boom-bust housing in economic decline – and I see, say historically, they are design responses to a decline in the market. I'm interested historically, okay. And I have to bring that influence into something which has to do with the contemporary structural solution, right? So let's say I'm designing with shingles, because shingles [were], in the early phases of Arts and Crafts, an attempt to address a humble American origin. So say we are in that position again now; we've had it with excess. The markets delivered us into this position of widespread poverty, economic decline, whatever; one has to think about the response to that architecturally.

So I may be trying to do something historically in terms of an environmentalist, bring those two things together and how they mesh together. You have to make a critical evaluation of those two things, but being forced to bring them together is the way in which one makes the evaluation. If you're not forced to push those things together, then they stay separate, and you don't make that critical evaluation. So, for me, design is the realm of critical evaluation, absolutely . . . Obviously the computer, as a collaging tool, is fascinating in that respect. But what I would look for is the presence of very disparate parts coming together in design and where the decisions are made, I would say.

Interviewer: On social responsibility: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Jason Griffiths: Well, from an environmental standpoint, I think, yes, we do question that regularly. So if that's what we call a social responsibility, then absolutely. I don't think we deal with it socio-economically, really, properly. I think that the way in which we deal with architecture in the mainstream, through sort of middle America, there's very little effect. Socially, I think that's the problem for – what we don't have here is a very good system where we can understand, say, mass production in housing in an interesting and affordable way.

Interviewer: Do you think the technology or technological paradigms have redefined the social responsibility of an architect?

Jason Griffiths: I'm trying hard to think of it in terms of a way in which I would say social responsibility. So, architecture is available to people who previously had no access to it. Not enough, I would assert. Okay, we do deal with it in environmental terms. We do it in terms of – if you are talking about social, if you are talking about society in terms of many people, not really, in my view.

Well, let's go back to my original point: my apprehensions about the de-socializing effect of technology. There's an argument to say that technology alienates people as much as it brings them together. Or it brings them together in [a] much more selective manner, let's say, because you can accept or reject an invitation in a very easy way . . .

Interviewer: Do ethical concerns affect the way that your school has adopted or implemented advanced technologies in the designs that you covered?

Jason Griffiths: Yeah, it does. We're not doing enough of it. It's simply a question of what we ask students to do, and this is a very difficult one. But first of all, if we're asking students to invest hours of their time on the computer, we better be sure that there's a good reason for it. What do you think? And secondly, we have to be very clear to students that they should not put all their effort into computational design. And I have been just about old enough [to have the] benefi[cial] experience in having seen several ways of this and how – when, let's say, rendering suddenly became a thing in the early '90s in England, I remember one or two colleagues and students who would really go ahead learning how to do it. They flew through school and went out, started earning a lot of money in design practices. And they probably had about three years until it became redundant. That's the technician's role.

And we can't just teach students to become technicians because the way in which computational design, or the drawing programs – how quickly they develop means you're quite quickly obsolete. And then time investment in learning a piece of software is incredible in that respect. But that reflects the way in which I consider teaching it as well. I'm no longer able to learn software and keep up with at all. If I do that, then my interest in history theory, my writing, my ability to teach studio, my interest in making things will all suffer drastically because I'm just spending the whole time trying to work out how to fiddle with this knob or that knob or buttons on the computer. So what we need to be able to [teach] students is that it's actually self-learning, learning a piece of software. You don't need to be wasting my time [learning] to mastering a tool. I mean, to be totally honest, if you're savvy enough, you can learn how to use Rhino without having to go through the course. You won't get the credits for it, but you can learn how to use those programs online. You can pretty much teach yourself how to use those programs.

I need to know what programs can do, but to do it is just going to push me into a position of redundancy. I don't want to end up as somebody who teaches software because that's a comfortable niche until the next piece of software comes in. And all you are doing is going through manuals, not asking yourself questions about ethical issues.

Interviewer: It's not the how, but the why?

Jason Griffiths: Exactly, yeah. I find your questions really useful in that respect, actually. Because you know, I sit down and teach Rhino, and after a while, you could just be doing this by yourselves. You're savvy; you can go out and learn how to do this yourselves. You don't need me.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Jason Griffiths: Well, I think, [the most pressing issues are] the ones that we've dealt with the least, which is how it affects design in the mainstream. Or, the way in which technologies we would use as a term in a critical debate or as an entity within a critical debate is one issue. How we deal culturally – and when I say culturally, I'm talking about what Marshall McLuhan said when he described culture as what most of the people do most of the time, which is very different from a lot of other people's interpretations of culture, which is high culture, which is what very few people do a lot – and I think we can look forward to something much broader in that respect. What I have enjoyed seeing is bits of technology used at home in interesting ways in order to improve one's built environment, or sort of as a pleasure in terms of play and that kind of stuff, and also to foster personality or personal expression in a way. So for me, the vast and uncharted territory of this isn't to do with biomorphism, isn't to do with how advanced one can deal with duplicate surfaces; it's really to do with the way in which we improve the role of what we do as architects within most people's lives. And it's a question I can't answer about its social value outside school.

Interviewer: Now we are able to simulate things because of the use of advanced technology.

Jason Griffiths: Sure. Absolutely. I mean, the simulation and the structuring of the architectural system of some sort is where it lies, where the real interest lies. So, what I'm interested in doing is trying to place these sort of antagonistic issues within a computing process and vice versa, right? So what I'm interested in doing is finding or developing ways of dealing [with] issues of personal taste, issues of personal difference, peculiarities of the individual through the computer in a way that it structures it and makes it kind of meaningful, and makes it permanent. So you deal with permanent differences as opposed to simply saying it's about optimization. It's about performance. No one talks about – no one talks about opinion when it comes to the computer. No one talks about gender differences. No one talks about, well, a whole range of different things outside performativity, structure, environmental constraints, all that kind of stuff. All that's easy to determine. It's the stuff that's indeterminate that really interests me.

Interviewer: They're all great! Is there any issue that I have not broached that you believe is imperative to understanding the implication of these technologies?

Jason Griffiths: Not that I'm aware of. If I think, I will tell you.

Interviewer: Thank you so much, Jason.

10) Jason K. Johnson

Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school, California College of the Arts (CCA)?

Jason K. Johnson: I guess I would probably say that, at a school like CCA, I wouldn't say that there was a single paradigm at all in operation. I think one of the things that marks our contemporary situation is that there is a varied approach, a varied synthetic. So in terms of the way we're operating, I would say there is no singular defining characteristic. I would say that the definition right now is more of a synthetic process of thinking at CCA because of its unique position in Silicon Valley. I think there is a definite pergola of systems thinking because there is a lot of software development and a lot of programming, etc., and I think that that is beginning to work its way into the architectural thinking. But, then again, there are already so many different threads of how that is operating.

So we can already see – even within the way the folks in Silicon Valley are operating, you know – somebody might say they are a programmer, but that means so many things these days. Compare [it to] if you said you were a programmer fifteen years ago; I think . . . it probably meant that really hardcore is the nuts and bolts of an operating system or a programming language. But, today somebody might say they are programmer, and they might actually be working with something like Python or Ruby, which have tons of layers which are between you and the actual program. So it's a kind of an interesting moment. So I think if it's for anything, there are people that are [puttering] back and forth with computational systems. And I think that is affecting things, but I'm [not] totally sure that I could say that there is a singular approach happening within our school.

Interviewer: How are they integrated into the curriculum?

Jason K. Johnson: Right now there are two tracks that are typically happening at our school. One might even be called traditional practices of teaching design in that same methodology of those: to have a plan and a section and all those kinds of really traditional architectural stuff. And . . . there is a parallel track that begins to happen which is a computer based one, and again, that even begins as a pretty rudimentary set of courses. And then by the time they are in their second semester at CCA, [that's] where they happen to be taking a basic programming class which is generally right now happening, something like C-Sharp or now we are kind of shifting to Python. So students are definitely getting a little bit of that.

But under their third and fourth semesters, kind of depending on their focus, we have three strands at CCA. One is urban scale; it's called the Urbanism and Landscape program, and so those students are shifting off into a thread dealing with mapping, urban scale mapping and doing some data, data mining, GIS etc. Another thread is called the eco, ecology, thread. And those guys are doing eco stimulation modeling of everything with ecosystems to water flows to airflows to solar energy. The digital design technologies thread is what I myself and Andrew Kudless cover or [are] getting involved with, which is digital fabrication and robotics. And those seem to have a very unique set of the things they need to get into, which is more the combination of learning how to control machines in a hardware way to achieve things in kind of basic electronics, and everything from soldering and making and printing circuit boards to doing actual [programming] at hardware prototype to software. So we are teaching them how to write Grasshopper script, teaching them how to do really simple either Python or Java scripts.

So whatever – so it's kind of a different track that our students are going through, and that's probably an important idea that the school has these three things. And what's fun is that, by the time these guys move back and do their thesis project, you might get a really synthetic grouping of things. And it's pretty rare that a thesis at CCA will just be on digital fabrication, you know. The school is committed to not just doing a narrowly focused thesis project; [they really] have to have some kind of idea or a site or client(s) or something associated with the project/thesis.

Interviewer: Do you teach the electronics, scripting, or programming in the design studio or in a different class?

Jason K. Johnson: It happens in both classes. I teach three courses. One course is called Robotic Ecologies, in which essentially I'm teaching a hardware and software course where the students are actually making robotic devices or buildings. The class requires different level of things, and right now mostly at CCA I've been teaching almost entirely either Python for Rhino or Arduino, which is a popular open-source single-board microcontroller. And there are lots of variations on that. That [course] has the two core things, and then I teach another class called Synthetic Tectonics, which is a course that focuses on digital fabrication. And mostly what that class is looking at is a component-based aggregate kind of system so the students are essentially building pretty complex computer models that go from those concepts to fabrication. So [I'm] actually showing them the process, like designing something, and then thinking about how it would be fabricated, and then pretty soon fabrication (the skin) getting harder in a kind of workflow, then manufacturing it, and then installing the piece. And synthetic – they always use multiple materials, so hybridized materials; so it would be a wood with plastic or a steel with a cloth so they can begin to test these materials in the computer and see how they are different to make in the physical world. And the third class that I teach called Sensorium, and that's a studio where the students are building essentially prosthetic devices. So students build augmented things. My students are building virtual reality augmented helmets, servo-driven wings, and also wired stuff.

Interviewer: One of them is a studio, and the other two are core classes, like there is something to take besides the studio class?

Jason K. Johnson: The last one, Sensorium, is an advanced option studio, and the other two classes are seminars. And right now I'm just teaching advanced seminars, and I coordinate something called dual digital media stream, which is two classes that they take in their first and second semesters. And those classes are – I'm not teaching them right now; I am coordinating them. But they are teaching basic stuff like Photoshop, Illustrator, InDesign, simple RTIS software. And in the second semester, the students are learning basically Rhino scripts, and then about two months of Grasshopper is generally what we do. And those are the core digital media classes.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

Jason K. Johnson: Well, we are a very young school, so we have only been accredited for five years. So myself and Andrew Kudless are the two coordinators of everything, and we've only been here for three years. I'm not sure what was happening before that exactly. And so it's a very young model for a school.

Interviewer: What do you think are the positive and negative implications of this?

Jason K. Johnson: Well, there is definitely a tension in our school between teaching students to use digital media and the kind of experimental – as a merge to experiment versus the second node would be teaching students to use digital media to produce drawings for buildings in a very traditional way. So there is always this kind of tension between certain faculty saying we should be teaching the students these software so when they get out of school they'll be able to do drawings! And there is another side of the school where Andrew Kudless and I come from, which is a little bit of both; it's actually saying how do we actually use these tools to explore new ideas and to push – to push ideas in architecture further. So, I think it is really healthy to attach practice and research. And I think for us the biggest challenge right now is to get students to think. [A] lot of what's happening is that they're producing form, and they are producing stuff; and they're not really worried about what they mean. They're not worried what context it's in. They are not really worried about what people or how people will interact with it.

I think a lot of what we're trying to get people to design and to build – that is really [a] regress in terms of geometry and form making, but also to begin to build things and place them in a location that they can learn from. So I think the digital design right now is – the way of production creation is pretty dramatic. Now I think what's happening in CCA is kind of healthy where we're really committed, making and fabricating and creating stuff for the public. I think it's a really positive thing.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? How?

Jason K. Johnson: You know, I think from my perspective I see definitely there is this movement towards – instead of just buying a software package and using that package, you know, verbatim, exactly the way the software designer wanted it to be used – I think most people right now are attracted to software that allow for various customizations and that allows a certain degree of creativity as a part of creating the interface. Like Grasshopper I think is really good. On the hardware side of things, I've been teaching a class also on 3D printers. So I've been having my students build 3D printers, and there is a real interest, I think, in much more the kind of DIY logic of building machines that makes things and building machines that can sense or understand their environments or begin to map their environments. So I think there is an interest in architects being much more assertive in their tools that they are using – the software, hardware-wise. So I think that's a very positive thing.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major keys issues that you see arising?

Jason K. Johnson: I mean, certainly, right now I think that 3D printing is going to get very interesting. You know, I think there is a pretty active committee happening within this area, not even so much within the architecture, but you can see it happening in product design and industrial design, and the fact that fifteen-year-olds are buying 3D printers and are modeling and printing things, that is a very interesting paradigm. I think the other paradigms that are very interesting is the issue of energy and forms and using things like electronics and sensors to actually modulate your buildings and landscape so you can sense what the energy needs are in the space, and the light needs of the space and buildings themselves can be changed robotically and calibrating themselves in real time.

So that would be a second one, and probably a third one that needs to be mentioned is much more a shift into thinking about the material logics of something and also simulating this computationally. [With] the fact that things like glass and concrete and wood have been traditionally approached like static entities, I think there is a whole new class of materials out there that are much more synthetic, and it might be thought of as alloys that have some shape and ray capacities. Or, there is the thing that might begin to gather energy or distribute information. So those are the three things that I can see being the next step.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Jason K. Johnson: In the studio environment, I would say my personal approach has been less about being critical of it, per se. We try to push it as far as we can. And then I try to use the seminars as a place to really be critical of the technology, and I think it is really interesting. I actually like the idea that within the design studio you're actually producing work that actually might have a kind of critical relationship, but students don't even understand that they are falling into, say, traps or into trouble until the end. So, I'm trying to make studios much more like let's use content, let's work through this content, and then there comes a certain moment where the students begin to realize . . . what they are doing. [In] my Sensorium studio, which is all about sensing and the human body and technology, I have students building these devices, and then I begin to introduce them to situations in which they're trying to understand that what they are doing is actually not totally new, that people have been doing and understanding this for many years.

So, the studio, it's kind of both; it's both best to explore the world, and then once we've explored it, then we'll have the capacity to be critical. I was educated at Princeton, where it's actually the reverse. It was a school that was much more about the critique of the world, and then we began to explore it through, say, form and geometry. I think it's compatible with what I said: to do the latter, which is to explore and then be critical and then explore and be critical.

Interviewer: Some professors may say it's hard within the time of studio, the three months or four months, to teach the students these new technological paradigms as well as ask them to be critical about it.

Jason K. Johnson: Right. Yeah, I agree with that. I have been in studios in which you wish that there was a little bit more thinking going on in terms of understanding what they were doing and how it fits in a broader trajectory. I'm not sure if it's the fault of the studio instructor, per se. I think the schools have to do a better job. You know, there is history and theory for very rarely engaged questions of technology use. They'll talk about the Bauhaus; they'll talk about machines and machine age, etc. What is very rarely engaged is systems theory, network theory, or contemporary theories of technology. It's a very rarely engaged contemporary series of science and technology and those sorts of 1960s theory, which I think is a problem.

Interviewer: That's true. It's a good point. I mean, why don't other classes support this studio class so other classes add to the critical thinking.

Jason K. Johnson: Right. Classes that are trying to tie what is happening in the '60s to the '80s and then into the contemporary conditions to have an understanding – we're not actually necessarily producing a whole lot that is new. So I think, for me, the big problem right now is so much that designers are, you know – it's really hard to tackle that stuff in three months.

Interviewer: Do you teach students to push back on and innovate beyond these paradigms? How so?

Jason K. Johnson: We're not very interested in necessarily understanding the paradigm especially. The way my Sensorium studio was set up, I'd basically use the human body as the kind of beginning point, and then I go from there. And basically it's a way of teaching that there are two ways to do it; one is the student that looks at it in a very superficial manner, and then there is another in which students really get into the politics of the body. And so, I try to craft a studio that could get students really excited about form and form generation so they can have a really great experience.

Another studio will be really into politics. They take this studio, and they still have the ability to have a critical conversation. There is not much content on the table that – it's about geometry and fabrication, but it's pretty shallow at this point. I think the fascination with those two things is over. There is a giving condition; they are kind of sustainability. It's amazing. It's a kind of a baseline at this point, and now we are shifting to a sort of moment when computational systems can actually be socially built, relevant [around what] they can actually do and it can take on [a] more weight[y] track.

Interviewer: Sure. What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Jason K. Johnson: Again, there is always this line between architecture purely about building, building being a master of construction, master of form generation, etc., and there is another way, which is designers being totally involved and designers engaging contemporary ideas. But right now it might be social equity. It might be related to various things like social networks, for instance; they are very interested in sourcing design. There is all this interest in these things that are super important in other fields, but they are not yet relevant in architecture. And I think other things that became really critical – I think, having the capacity for the average designer to rapidly understand something like building performance I think is a really important thing. So it's digital tools that really allow the average person . . . to learn energy stimulation very quickly The average person tends, you know, [to] basically understand their project and understand the context of the project very rapidly, so those are things that can be really critical.

Common languages and common tool sets – that also has been interesting, having the ability to jump on any computer anywhere and pull up a model and interface. That model is very important, and it's happening again in these other allied fields. And I think architecture will really get great things moving forward. The idea of like a cloud-based software system that would be cross platform and open source is a really critical thing.

Interviewer: Thank you again, Jason, for your time, and I really looking forward to seeing you at the ACADIA conference.

11) Mohsen Mostafavi

Interviewer: **Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at Harvard, Graduate School of Design?**

Mohsen Mostafavi: Yes, they do.

Interviewer: Which modules/paradigms of digital technology are informing design pedagogy at your school?

Mohsen Mostafavi: I think one of the things that's very important is for us to think about the reciprocities, the relationship between technology and design. So the main paradigm is not the paradigm of technology itself or the paradigm of design, but the paradigm of the relationship between design and digital technology.

So, it's very important for us to not separate digital technology wholly from traditional modes of technology. We have, as you will notice if you go downstairs at the workshop, work that combines traditional tools, hand making, handcrafted things next to 3D printer digital technologies. We are very much seeing that we want to build bridges between what was thought to be traditional as well as what is digital, rather than the digital separate, for example. So, to give you an example, we've had a course here for a few years, which is appearing under the rubric, for example, of digital wood, and it's really exploring the material qualities of wood as a traditional material but actually using computational techniques and digital techniques to try and create special models, shapes, forms, structures that are transforming the behavior of wood in terms of, for example, its pliability, how it bends, how it responds to moisture, and things like this. But it's actually also very much linked to digital technology, so there is a hybrid model that's at stake, one; and two, the relationship between modes of practice and modes of making this, how one affects the other is something that I think is very much part of the paradigm of the school.

Interviewer: In some schools, they have a specific paradigm, for example, like network theory, information theory, general systems theory. This is what we're going to teach, the assignments or projects will be driven from that general systems theory, for example, where they emphasize the unit's connection. In some schools they have a mix of different paradigms. Do you have a specific paradigm at the school?

Mohsen Mostafavi: No, we don't. We are a big school, and therefore we don't have a singular paradigm. We actually don't believe in singular paradigms. I think we are a school that – at any one point for its options studios, we're offering over 20 studios for just the options. So, it's very difficult to have a singular paradigm because we want to have certain studios that are very much focused on materials, or dealing with urban issues, and so the mechanisms that they use can never be exactly the same. And I think that's part of the richness of the school that we believe in a diversity of practices.

At the same time we do have a very strong research component. So, for example, in terms of the utilization of digital technologies, we want to be at the forefront of that research, but that doesn't mean that we want everybody in the school to be doing that. That I think is something. If you're a very small school, sometimes you can say, "This is the direction for the school as a singular." But, I think for a school like this the question of the diversity of research interest is very important, and so I think what we can discuss is really what is that diversity, what are you dealing with not just in terms of technology, but because we're dealing with themes. So our approach is more thematic. So there are issues, and there are geographies; and at the same time obviously issues and geographies have a relationship to the use of technology. So their relationship is something that affects the work. Also, we are not just using technology; we are a very strong believer in being the number one design school in the world. Therefore, the question of design is something that is very critical for the school, and it's the interrelationship between design and technology, not, for example, digital technology by itself. That's what I mean.

Interviewer: When you do the meetings with the faculty, do you discuss specific philosophies or a specific way of teaching in the design studios, or does the studio professor have that freedom to come up with this his own?

Mohsen Mostafavi: No, we have core programs that obviously are mainly taught by people who are here full-time in the school, or some people who are visiting but on a very regular basis. Then, for the core, the specific, each year of a studio has a direction, and the leaders of that particular track discuss together what is the aim. So, for example, in the first year of our architecture program, we have a very strong belief in the understanding of issues related to projection and projected geometries. This is not the same as digital technology, but really it's also very much linked to that. So projected geometry is our understanding of geometry, but also you cannot teach it without understanding digital technologies and understanding how things are fabricated. So things connect.

But our third semester is one that is much more focused on questions of integration of different aspects of design, from structures to multi-functional buildings to environmental systems. Now, there the emphasis is not going to be so clearly or directly on geometry, for example, but people by then have a background in this. So it's not like a church where you have a priest coming to give a sermon about "this is our philosophy." I think we have a certain set of practices, certain interests, and then it's very clear that in terms of the way we develop a sequence in the core program how we can address those themes like, let's say, the relationship between the political and the city, the materiality of architecture, the question of technology, the role of art practice, the status of the site, the connection to landscape – there is a multiplicity of things that people have to cover. So each one of them is understood in terms of an overall set of interests of what is needed to cover the core, but then it's broken apart into digestible components.

When it comes to our options studios – this is something – [we] pull [from] very different backgrounds. Remember that in our school the thing that is completely different – it doesn't exist in any other school – is that the students who are in the master's program, they are able to take options studios in other programs. So you can be an architectural student, but you take a landscape architecture studio, or a landscape architect who takes urbanism or urban design studio and things like that. So partly the philosophy of the school is: what are the key issues today that are relevant for architecture, and who are the people who are practicing that? In part, we rely on our own faculty, and then in terms of their selection, we choose people, not randomly, but we choose people who then are doing some of the most interesting things in relation to the five or six areas that we have decided. So those areas, for example, could be that something relates to technology, something relates to questions of geometry, something relates to questions of sustainability, something relates to architecture's connection to urbanization, something relates to materials, and these are also research areas.

All of them are affected by, for example, the way in which we develop digital tools, and – because we see them as catalysts for being able to imagine . . . But we don't see them as the end product; we see them as a means to try and develop important ideas. For us the important thing is really 'what is it that you're producing?' and then the responsibility of the school is how to create an enabling framework. What is it that we've done to help our students achieve that kind of project, that kind of proposal? So this is as much about our beliefs and then the tools that people need rather than the statement of a singular philosophy. So, for example, if somebody says network theory or whatever, then I think in architecture it's a problem that a lot of the time schools or architects have ended up doing a project that's an illustration of the philosophy, of the idea. And I think we do not believe in this idea of architecture as an illustration of things and other disciplines. We have to really think through design, be inspired by other things, but we do not operate from the perspective of a single or singular philosophical perspective.

Interviewer: How do you integrate the different technological paradigms that you're using into the curriculum?

Mohsen Mostafavi: . . . We actually cover a lot of things in workshops, in classes, because we believe very strongly that people imagine or work through a catalyst, and therefore having the knowledge to use different kinds of software, different kinds of technology is a – without them, it's very hard. It's harder to imagine. It's like not being able to draw today. But, at the same time, I think we are trying to make sure that we are emphasizing as much computational skills, digital tools and techniques, as much as we do with things like hand drawing. At least that's the aspiration – to do that.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

Mohsen Mostafavi: Well, the school has had a strong approach that has been very much related to the core issues of the discipline of architecture. So we are a school that has been, in terms of a paradigm, very much based on architecture as a discipline that has been going since really the founding of the Graduate School of Design, I think. This is in 1936, but actually, there was a school of architecture since the 19th century. So, there is a strong disciplinary drive. I think it's not helpful to go back too long, but certainly since the time when Walter Gropius became the Chair of the Department of Architecture, the whole idea of focusing on architecture has been a very strong component of our work. I think that what I am discussing, which is the analysis of architecture as a discipline together with the relevance of themes related to the relevance of geographies, [works] together with the relevance of technology. This is something that we have been developing as a more explicit project in the last four or five years, but actually, the idea that this is a design school, that pays a lot of attention to the core questions of architecture and also to the city, the relationship between architecture and the city.

Now, this idea is becoming expanded. We are thinking more also about the relation of architecture to landscape. Landscape plays an important role. Urbanization plays an important role. So partly what we are doing is not just the application of these paradigms, but also a form of questioning the very nature of the discipline because now when you say design, what does this mean? When you say architecture, what is that? When you say urban design, what does that mean? What does urban design mean today? I think part of our responsibility is to also question, at a very kind of systematic way, the very contribution of the disciplines themselves.

Interviewer: What do you think are the positive and negative implications of these paradigms, the technological paradigms used within the design studios? Did we gain something? Did we lose something?

Mohsen Mostafavi: . . . If you try to focus the emphasis purely on technology for technology's sake, then you end up with the valorization of technology. You end up with something that really only promotes the technology. So our task is not that. If you set up technology as a paradigm, then you actually advance some things in terms of the development of tools and techniques, and as a result of that you come across some outcome which may or may not be interesting, but actually the driver becomes the technology. I think the sort of disadvantage then would be that you create a situation where it's difficult to understand the relationship of the tools to issues of design, to issues of subject, the themes, to issues of relevance, and so on. And, therefore, I think what we do is probably characterized by the notion of temporal finitude. I don't know if you understand what that means, but by that I mean that you develop a project, and then you have to examine the consequences of a project, and then this becomes almost like a feedback loop because until you've kind of examined something, it's just like a factory, as a sort of endless process to try and develop things . . .

You have to have parts of the school, aspects of the school, that are emphasizing one thing over another. You cannot have in a school of this size everything being balanced constantly. So you need to have people who are working on certain aspects of digital technologies, and those things are not always going to be with site, with program, with outcome. And you're doing that because you're also trying to be at the forefront of certain kinds of investigations, and that is necessary if you're doing research because you want to exclude some factors in order to be able to emphasize some others. So I think in the context of a school, it's necessary to have innovative models of research, and at the same time, you have to have tools for the assessment of the outcome of that research.

Interviewer: To test the design we use simulation programs, right? We use the digital technology to simulate or create this virtual environment and test our design by inserting data?

Mohsen Mostafavi: Yes, except that these simulated environments, you shouldn't confuse them with what is actual environment, so [that's true] as long as you are willing to accept that the condition of simulation is itself a very specific circumstance. So it has its own realities, and therefore it's not the same thing once you've simulated the conditions. Maybe to some degree it parallels some so-called real situations. But we work with visualization techniques because it helps us to see things, but it also helps us to imagine. At the same time, we don't necessarily confuse those things for the reality. We understand that this is a parallel condition to some kind of reality. So I think that's something that's important, how you work with the concept of analogy and how the analogical is a way to create sort of parallel worlds. But they're not the same worlds.

Interviewer: What about positives? What positive aspects do you see with the use of this technological paradigms?

Mohsen Mostafavi: Many of the technological paradigms help you imagine conditions and situations that you wouldn't be able to if you weren't assisted with that. So, in the same way, the capacity to draw helps you imagine otherwise – other things, more things. And I think the technological paradigms also, to some degree, lead to their own outcome because it's a form of distancing from the realities of [a] brief program site, this kind of thing. So sometimes these things lead to formal situations, and these formal situations also have their own value; so that's a positive thing. It's also that, in a certain way, it moves towards some aspect of optimization, and that also is in terms of a kind of efficiency of a system. It has some possible benefits if you don't take it, for real, 100%.

But also, I appreciate the potential abstraction of some of these paradigms for what they produce because the product itself – it [separates] from application, from use immediately. And so it's something that you might think has a connection with some function, but the functionality has been taken out. And this can also be inspiring to imagine certain models, shapes, forms that are not always the same as prototypes or types, you know, the way that you might imagine the typology of hospitals or the typology of houses or things like that. I think that kind of openness is actually relevant somehow as a step towards thinking in design – as long as you don't think that it's the final step.

Interviewer: Do you believe it has helped shape the critical thinking in architectural

education?

Mohsen Mostafavi: . . . Technological paradigms are not necessarily critical thoughts by themselves. That's why I'm spending all the time explaining the way in which you frame a project, or you frame your actions, or you frame the idea of a certain kind of paradigm because we are in a school that believes in the situatedness of things, in the way that we make architectural projects that are engaged with the world. But we also understand that, in order to do the most innovative projects, you sometimes have to go against the grain and create certain circumstances that help you be more imaginative than you would be normally. That is why I have written or I talk about the concept of constructed imagination, that you imagine in certain ways. So part of our responsibility is really to see, in the context of a school, how we might be able to generate those circumstances.

Our thinking is slightly different than the way that you're asking this question about paradigms because, I think the way you asked the question, these paradigms, for me, are tautologies. And I don't believe in tautologies. So you can ask the question about paradigms for another three days, and still my answer is always going to be both accepting and escaping. It's never going to be wholeheartedly embracing a singular paradigm because I think that you have to be more opportunistic. Use some things. See what you can do. Throw this one away. Go on [with] something else. It's not like a religion, so that's why it's necessary to be—

Interviewer: Skeptical?

Mohsen Mostafavi: Well, skeptical, but also to be strategic with the way that you utilize things. And also I'm trying to say that every school has to decide what are the kinds of things that makes sense for them, where are they, what is the scale of operations that they're using, what is going to be their contribution. All of these things affect the answer to your question.

Interviewer: **Do you believe this relationship will evolve over the next 10 to 15 years? That the way we teach architectural design will change?**

Mohsen Mostafavi: I'm sure that in 99% of places it's not going to change that much. I think that what will happen is probably that [in] most schools the idea of tools and digital tools and computation will be more taken for granted, and so it will not be such an unusual thing. That's still – in certain schools, there is a resistance to it; in other schools, there's a total embrace of it; in other schools, there's a fight against it. And so I think that in ten, fifteen years' time tools and techniques will be something which [are] just accepted, taken for granted. And perhaps as a result of that, there will be more emphasis on actual ideas. It's already happening.

We've had a lot of emphasis in the last five or ten years really on the global situation, on the politics, on the environment, on the relationship of architecture to the political circumstances of cities and the international situation. We can also see that now in addition to those interests which remain very important and valid. There is a greater emphasis on questions of architecture's relationship to its own disciplinary foundations. And, [did] you see that the next issue of *Harvard Design Magazine*, which is just coming out, is called "Architecture's Core"? And so schools will have to also face the question of what are the issues that are internal to a discipline . . . There's a level of specialization, a level of knowledge, a level of know-how, which is not just to do with the relationship of architecture to its reception or to its political consequences.

So I think that this is something that is going to be emphasized more. I do think that the limitations of resources will need to be understood in a different way than just sustainable architecture. And so we have to be much more innovative with the way that we design not just with more limited resources, not just being cutting [edge] and being more efficient, but really in a different way of kind of thinking and designing. I think schools of architecture will have to think, as a result of that, more broadly about the environment. And so, on the one hand, there is the response to technological advancement. On the other hand, there are socioeconomic cultural circumstances, and I think the schools will need to make more connection with those things. We probably have too many schools anyway. And one of the things that would be beneficial is if there was more debate about what was being offered in pedagogy, what schools were doing. There's very little of that because there are a certain sort of assessment criteria that most schools can't fulfill by ticking boxes.

So, what are the things, and should we have so many schools? What is the criteria for having a school? I think these kinds of discussions should also be more open because it's not just a matter of what should the schools do; it's also the responsibility of those people who are accrediting to not be just so pedantic about the nature of education and to really see it in [a] more intellectual, more philosophical way. I think, that will affect – equally it can affect architectural education. Like, if you're going back to Kuwait and there are not that many schools, then you're going to have two schools. You have to say what kind of a school do we want? How should the schools in Kuwait be similar or different to some other places? Because if you don't have it, it's a good opportunity to actually think at a more primary level, more fundamental level. What is the responsibility of the school? This is something we think about all the time. We do not think of our sole responsibility [as] just trying to train people or pass the exam or whatever. We see it as our responsibility that we are architecture and design education, and also we have a responsibility of how to shape the very nature of education. It's not just about training; it's actually about questioning the method of training.

That's why I said you have to say, "What is urban design today like?" Until you ask that question, you don't even know what it is that you have to teach. Unless you ask the question about what are the kinds of things that architecture should or shouldn't do today, you are just going to assume that architecture is about a professional discipline that's about building houses and offices and whatever, and whatever happens in a certain region of the state – that's what it should do, so you just see yourself as a training establishment. We do not see ourselves as purely training. We see ourselves as training people for the future, but we see ourselves as questioning the very nature of that training while we're doing it. That's why your question about the curriculum is pertinent because the curriculum is the mechanism through which you implement your ideas, your philosophy about design education, and that's a very difficult thing. It's not a very simple thing.

Interviewer: Do you give classes on social studies, or take into consideration economical concerns? You mentioned Walter Gropius, the founder of the Bauhaus, where it was a reflection of what was going on at the time, like the idea of mass production, cheap design is a good design – good design for everyone. Do we have the same concerns or questions right now?

Mohsen Mostafavi: See we don't have the same concerns at Harvard, but we have concerns that are very much rooted in both design imagination and socioeconomic cultural practice. This book, *Instigations*, is just going to come out in the next few weeks, and it's a book that is really about the history of the school. It celebrates the founding of the school since the dean at that time – who was called Dean Joseph F. Hudnut, and he hired Walter Gropius as the Chair of Architecture – and I have written about the current vision and position of the school. So, maybe when that comes out, you can get that. But, you know, we believe in the idea of design leadership and design excellence through societal engagement, this idea of engaging society with design. We are not a social studies school; we are a school of design that believes in societal transformation though design. That's a slightly different thing.

If you look at the history of architecture after the war and things like this, there's a lot of commitment to the social project, and therefore architecture assumes a kind of symbolic response in relation to this idea of the social, building schools, building universities, building hospitals, things like this. We believe in this project, but actually we also want to emphasize the role of design and its transformative capacity. So much was built, for example, in Europe, in England, in the name of social housing, but many of these projects are very problematic. They create very negative environments. So part of our responsibility is also how, through design, we can actually create better environments, better futures.

That's a slightly different take on the idea of the social – simply that housing has a social component, therefore it is good. We don't make that argument. We make the argument that we need to create beautiful environments within which is a mixture of activities and events. Therefore, our posture is different than from the social to the architectural. We are much more involved in the reciprocities between the architectural and the social, the architectural and the economy. Now, because we are a graduate school of design, we have architecture landscape, architecture/urban planning, urban design – it also means that we have architects next to planners, we have social scientists next to architects, we have geographers, we have anthropologists, we have economists, we have economists of the city, we have people who deal with real estate. All of those people are in the school, the question of public-private.

. . . Every semester, we are offering 65 to 70 courses. So, of course, a student can take in architecture classes that are about urban theory, that are about the city, that are about the economics, that are about simulation and design, design by committee, digital interface, lots and lots of different things. So actually it's very important that people have choices and they have options. But, because of planning, we have a very strong political and economic and cultural agenda that I think is available for the architecture students as much as it is for the landscape architecture students or urban design students. This mixture is very important.

If you are a student here, you actually are taking classes also in other fields, studios in other fields. So the whole nature of the education is actually trying to say, 'Architecture is related to landscape. Urbanization is related to landscape. Architecture is related to materials.' So, you are given a field of activities, and that's different than a school that has only architecture, you know? We use this relationship to the other disciplines and believe very strongly in the importance of collaboration with other disciplines.

Interviewer: I've read also you work with MIT as well?

Mohsen Mostafavi: Students who are here can also take courses at MIT. Harvard and MIT have had a long history of connections, and now we have a new program which is a computer distance learning called EdX, which will be a collaboration between Harvard and MIT. And then now other schools are also joining this collaboration, which is how you also think about the future of education and the impact of technology on learning. So, a lot of these will be exploring the relationship between distance learning, or having some classes, things like that, that are on the website or communicated through the web. And then how does that change the physical environment of the classroom? How can your physical classroom be different when you're offering, let's say, certain things through distance learning? So, yes that's happening, though the emphasis of Harvard and MIT is very different. The emphasis of them in terms of their research interests are different; the emphasis on design is different, so sometimes it's also a good thing to have collaboration on some things.

Interviewer: The question is about the critical thinking, right? With the use of technology, how do we promote critical thinking in design?

Mohsen Mostafavi: Well, technology doesn't replace other kinds of knowledge that we must possess. This is why I think that the technological paradigm cannot be a replacement for design, for the design imagination. So, I think that you – in the context of a school, you have to decide whether you're a technology school or whether you're a design school. Our concept is that we want to be a design school that uses technology. We do not want to be a technology school. I mean, you know, MIT is a technology school, but we're a design school. So, I think the use of paradigms in terms of critical thinking is very important if you also pay attention to the way in which you develop critique, you develop analysis, you develop methods of critique, and that is also a different kind of knowledge, a different kind of practice, different kind of eye, different kind of capability than just being technical, you know. I think that technology and technique are, for us, a way to try and arrive at alternative models and to be able to implement alternative models, you know, to arrive at different models because we use those tools to – as I said before, to help us imagine. But also they're tools that actually help us implement.

I think that is very important, but [in] critical thinking, you need to also study all these other things that you're saying, understand the city, understand the environment, have a sensibility towards how buildings look, to be able to deal with film, photography, culture of cities, then have this knowledge, then have a sympathy towards landscape, be a kind of sensitive person. All these things develop your critical thinking capacity. This is not something that just comes as a matter of routine, so you also have to have a school that really has the right kind of students, the right sort of faculty, the right kind of environment. So for us, it's very important that we are in the context of a university that also believes very strongly about the humanities. We are a research university, and we spend as much time talking to our colleagues in the humanities and English and whatever, as we do with people in engineering. This is very important for us.

The same way that understanding, in the context of American society, [is] dealing with public and private issues is important. We're not operating in the context of a country where the state does everything. So, it's a hybrid. Some things we would like the state to do more; some things we have to realize that it's really a kind of private economy in this capitalism. So, what is the relationship between the sort of division of the environment that's brought about by the citizens and the one that's brought about by through capital? I think these are important questions today; if you want to transform the built environment, how do you go about doing that in a place like America? This is a very difficult question, but I think we're engaged with those sorts of issues.

Interviewer: Did you believe it's too much to ask the student to think of all of these issues within the academic year?

Mohsen Mostafavi: No. Well, we don't ask them to do everything at the same time. They have three courses, and then they have a studio. And then they go from one studio to another, and the nature of one studio can be very much about a particular kind of formal aspect, or what you will call technological paradigm in design. The next one can be more about landscape. The next one can be more about the city. So, part of the idea of that what is needed or the diversity of ideas is coming from the fact that people have multiple choices and they have more options. They can choose. And also not every student has to cover everything. People should decide what to do.

We have to have some basic understanding of things. This is why the core – and the values of the core program – in the first two years is very important. But you also want people to develop different interests. You want someone to be interested in urbanization and into global cities, and another person to be interested in crafts, and another person to be interested in the use of digital tools and techniques to create buildings, and somebody else to think about materials. So, we are not pretending to say that everybody should be the same. We actually want to create difference. We want to create diversity. We want to say today's society needs all sorts of different design professionals, and it's very important that we have people who are very passionate about what they are doing and what they are interested in.

Interviewer: From our talk, I sense Harvard is not enforcing technology as MIT, but more is taking digital technology as a tool and not the design project.

Mohsen Mostafavi: That's true.

Interviewer: But – I won't say you're anti-CAD like what they call Cooper Union – but you're kind of similar to Cooper Union's philosophy because they don't enforce technology on their students or their projects. They let the students choose the tool and collaborate in their work, but with critical thinking, with the "why" question. Why do we use it?

Mohsen Mostafavi: Yes, but I also [want to] emphasiz[e] the fact that we are a big school. MIT, for example, is a small school still compared to us in the design field. Therefore, for us it's very important that we have the best. Our program in terms of design related to digital tools and techniques is much, much, much more advanced than MIT, but MIT has a technology component that's not part of its design, where they're doing research, let's say, in the media lab. But that's not really in the school of architecture; that's not in design. We're not the same as Cooper Union in the sense of John Hejduk and drawing and things like this, though we have some people here [like that]. So, the point is how to be a school that is at the forefront of multiple practices, rather than one kind of practice. I think that's something that I'm saying.

I'm also saying that we have research labs here that don't exist in other schools. It doesn't exist at Cooper; it doesn't exist at MIT in the same way these research labs are clusters of faculty and students who are working on different themes. These are the labs that are now directed also by Hashim Sarkis. There are people who are doing responsive environments; there are people who are working on questions of social agency, so these themes are not just technological. Some of them are technological; some of them are not. Some of them are about the schools of the future. This is different than what you are categorizing as Cooper Union. I think that you should not be safe, artistic, technological. I am saying that the world is more complex now. You need to accept and embrace technology. You also need to understand the way in which you create distance in relation to that technology. It's not like we want to have everything. We are working in the context of a school that thinks very strategically about the future of design and puts design in relation to the future of the environment, the betterment of society at its core mission.

And because of the fact that we say the way we do that is through the phenomenon of constructive imagination, this is not something that happens just poetically. This is also something that happens through the understanding of the advancement of technology and their embrace of technology. Therefore, this is like a network of themes and issues that don't produce, unfortunately, a singular paradigm. It in a way accepts the fact that in today's society we need to be thinking in multiple ways, and sometimes in order to go where we want to go we have to also embrace things that we might later on have a distant relationship to – and so this is the thing that I'm putting on the table. And because of our size, I think this plurality is something that's very important. Not to say anything goes, but to say that we need to – we're big enough now to be able to actually achieve multiple things at the forefront of research. Thank you very much.

Interviewer: Thank you.

Mohsen Mostafavi: Thank you. Good luck.

12) Nader Tehrani

Interviewer: Regarding the influence of technology in contemporary architectural education: Which models/paradigms of digital technology are informing design pedagogy at MIT?

Nader Tehrani: I don't know which specific paradigms you're referring to, but I don't see that we have a single paradigm informing the uses and abuses of technology precisely because we see technology as a malleable medium. It's not an end; it's a vehicle by which to research. Digital platforms continually change, so whether you're talking about hardware or software, they're always under transformation. And then intellectual paradigms – depending on what intellectual paradigm you're operating under, you're asking different questions of technology critically. I think the key thing that we've done in our school is that we have not assumed a linearity between analog thinking and digital thinking. They are things that happen simultaneously from day one, and we introduce problems of technology from the very first minute in first semester core.

So, by the time you've finish core you have a broad technical and, if you like, intellectual foundation in building, in fabricating, in visualization, in generation. But of course it's different whether you're working on a platform in the most mundane sense. Platforms of AutoCad, Rhino, or Digital Project – these things do different things, they have done different things over the last 10 years, and they will do very different things in the next 10 years.

Interviewer: Some schools, Professor, they use systems theory for their technological paradigm where they focus on the units to create a system for the whole. Others use network theory frameworks.

Nader Tehrani: Our school does not ascribe to one of those. It's a critical field of evaluation and interaction between different theoretical paradigms.

Interviewer: How are they integrated into the curriculum? What kind of assignment? What kind of projects?

Nader Tehrani: . . . In the M.Arch program, we do it from the first semester in the geometric systems and representational skills course from the very beginning. We have a fabrication laboratory within which during the winter session we do a building-based research, and in that semester, in that moment they become familiar with all of the tools – whether they're laser cutting, routing, plasma cutting, water jet – there's a whole range of media to which they become accustomed. And at the advanced level, you have the course retransformed, integrated with electronics and interactive technologies. So, in a way, there are many ways in which this is done in relationship to design and computation, design and geometry, design and fabrication, design and electronics.

Interviewer: And there's no start in one place to the next?

Nader Tehrani: Well, in the foundation we start with geometry, the most rudimentary way, then fabrication, then, if you like, digital platforms in general – understanding of all of them – and then in the advanced courses, the electronics.

Interviewer: When you say geometric, is it abstract thinking of creating geometrical shapes?

Nader Tehrani: It is the discipline of geometry, so from descriptive geometry to algorithmic thinking. Otherwise it is both formal and numeric because you also learn scripting in that same semester. In the first year, they do models and all of the techniques associated with constructing relationships between plutonic solids, ballooning, tangency, variation, in a way subdivision, pixelization, tessellation. There's a range of exercises that everybody will go through to do certain permutations, to know at a minimum what are the tools available for not just composition, but exacting parameters. Does that make sense?

Interviewer: Yeah, and do you use a specific program for that or are they open? Rhino scripting or Grasshopper scripting—?

Nader Tehrani: We try to open up those programs because we know that they are conventional, and because they are conventional they will change. And so you need to teach the students how to think rather than how to be bound to a program. We're not a program-based education.

Interviewer: So you start teaching them with hand drawings and sketches?

Nader Tehrani: We don't start with hand drawings and sketch models. We start with drawing on the computer and drawing by hand at the same time. Eye-to-hand skills have one set of criteria. Eye-to-mouse skills are as fundamental as eye-to-hand skills. You don't go from eye-to-hand to the mouse. The mouse has its own paradigmatic requirements, and the hand has its own. One does not follow the next.

Interviewer: And there's also another complexity to that level with the scripting, mathematics, and program.

Nader Tehrani: Ya, of course, of course.

Interviewer: How long have these models-paradigms informed your curriculum? Who introduced these models at your curriculum (professor, administration, or student)?

Nader Tehrani: Well some things pre-existed me, but I'm the one who instituted all of these things that we are discussing right now. But the computation pillar was there way before me, and their arena of research is to shape grammar. George Stein is the guru of that realm of thinking, but he's more invested in the SMarchS and PhD program and not the architecture program.

Interviewer: You said you had also an influence on the direction of the way they're—

Nader Tehrani: Computation? Not at all. Zero. Computation tends to think of itself as a semi-autonomous pillar. I've had a difficult time to – and so we needed to forge forward with or without them, so they have their own vitality, but they also have their own autonomy.

Interviewer: But did you introduce the programming to the program, like scripting, or was it there before?

Nader Tehrani: They actually taught scripting on their own terms, and we taught it on our own terms because they are not interested in the instrumentality of scripting and we are because we see a dedicated relationship between economy, materiality, geometry, the means and methods of fabrication, and the complex process that produces built artifacts. There's a commitment to computational and generative thinking, which is valuable on its own merits. And it has a theoretical foundation, but it is not necessarily invested in the constellation of contingencies that architecture requires as a discipline.

Interviewer: Seems that the architecture students, they work also with the media lab—

Nader Tehrani: That is really at the advanced level. And when I said the "How to build almost anything" course used to be in the Center for Bits and Atoms and very few architects used to take it, now it's become part of our department also. So yes, we have a school that starts in architecture and from architecture goes to the media lab, from architecture it goes to computation, from architecture it goes to art, culture, technology, from architecture it goes into urbanism, from architecture it goes to history and theory. So we have a very small school, but with a very prolific and projective understanding of where the students can end up.

Interviewer: What do you think are the positive and negative implications of the use of the technological paradigms. The opportunities—

Nader Tehrani: It's not positive or negative . . . Technologies have always already been part of generative processes of architecture, the way that stone masons carved a stone, the way that geometry impacted the Renaissance, the tools that it required in order to project all of these disciplines are technological foundations. In that sense they're a means to an end, and you can say positively these technologies expand the generative and ideological possibilities of architecture. Negatively you can say you're defined by that medium or you're constrained by that medium. But maybe not. Haven't you heard about all those people who walk around and say, “Arg! Our students don’t know how to draw anymore. They’re always on the computer.” Well, what is it? The computer is a generative device. A great person on the computer is better than somebody who doesn’t know how to draw by pencil. I think that basically the question is not whether it’s positive or negative; the question is about inevitability. You’re working through different media that impart certain possibilities.

Interviewer: There’s some worries that we’re teaching students how to master a tool, or how to master a program, so we limit their thinking with that program; this is one of the concerns.

Nader Tehrani: Yes, I’ve heard that before too. But, actually, if you don’t master a medium, you can’t conceptually expand it. So it’s a catch-22. And lacking intellectual expansion is not only binary, but it’s projective. You need to show the way in which these two can propel each other, and you cannot do it without the technique. The technique is actually quite important. That’s why conical projection is so liberating and constraining at the same time. Can you imagine an architectural discipline today without [Vincenzo] Scamozzi or Palladio’s Teatro Olimpico? You can’t. Right now we can’t, but there was a moment where that must have been the most radical invention. Now, does that mean that we have to live by the conical paradigm? No, but it has opened up many architectural trajectories. I think other things are happening around us that at once are technique-based but also are translatable into cultural terms which are quite expansive.

Interviewer: How do you believe technological models shape the architecture pedagogy historically? Because I’m looking at the Bauhaus, the Vkhutemas in Russia – I’m looking at the constructivist movement and how they influence technology and methods of fabrication, but the use of PC or computer—

Nader Tehrani: We have seen crafts-based theory of the 19th century arts and crafts movement; we’ve seen that used in both progressive contexts but also very conservative contexts with the kind of moralistic tones that came with. In modernism we’ve seen the way in which technologies heralded at the theoretical level from mass production and the changing and democratization of society. We’ve seen in most recent theories the way in which mass customization has made its own polemics.

But I think, ironically, technology is not only instrumentalized; it’s also abused. So it’s used in all of the ways you would not have imagined it to be used. So, for me, the element of cultural criticism and the context in which technology is manipulated is as important as the instruments of technology. So, in a way, I think the question needs to be paired up with the arena of critical thinking. How it is that you believe the technological models are shaping architectural pedagogy in the context of critical thinking? That changes the whole question all together, because then if you want to ask a question about mass customization now, you have to understand what mass customization [is] in China, in Iran, or in the U.S.

The U.S. ends up being a very stubborn context because the industrial foundations are so strong that it has institutionalized windows, walls, and everything. You can't customize, not because you don't have the technology, but because you have an economic trade base in order to do that. The economy is calcified. In Iran or in China, where you don't have such developed industries and all of that, they'll build anything for you. With one or two laborers they can do more than what they can do here. [Like with the] digital router, they can do more because they're not constrained by economic factors in the same way that we are here, whether it has to do with unions or whether it has to do with dominant companies that have, in a way, cornered the market on some things. So, context has a lot to do with technology. Technology has a formal problem; as a formal potential, technology is an economic engine, technology is a social engine. So these are the contexts in which the question should be evaluated.

Interviewer: Some people say we moved away from the custom mass production to the information technology era right now, which is already sharing data through programs. Do you believe this relationship will evolve over the next 10 to 15 years? If yes, how do you see that, the relationship between technology and technological paradigms in architecture?

Nader Tehrani: Broadly speaking, I think technology has made architecture available at a global level in ways that were never conceivable 10 years ago. The hierarchy between the masters and the stars and the pupils was much more defined. Now the way in which the globe – its protagonists, its juniors and seniors – are changing the discipline has been flattened because the student in Pakistan and the master in Arizona maybe end up doing similar things, or the student may do better because they have access to information, to knowledge, and potentially to technology in ways that can radicalize the discipline. In that sense, knowledge is power, which is to say that information is power.

The bigger question is if anybody and everybody can do architecture, how do you distinguish between rigorous feats of architecture and just design in general? Styling will become more pervasive as anybody can develop certain aesthetics in the broadest sense. But let's just say that provisionally that discipline requires elements of material, spatial, and intellectual precision without which it does not rise to the occasion of architecture, or so I would like to think. So the bar gets raised much higher all of a sudden. I'm not saying that this is where it's going in the next 10 to 15 years, but I'm saying because of the democratization, because of the accessibility of things, the stakes will get much higher.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major key/issues that you see arising? Is a specific technological paradigm, you think – this is the future, this is what everyone will use – has a lot of potential or is there something new that you think is coming?

Nader Tehrani: I'm not sure if I'm well-equipped to answer that question, but I'll probably say that what we've witnessed since the Reagan years and its economics is the radicalization of the difference between the rich and the poor at an exponential level. The question is really whether – and the developed countries can be adopted in unprecedented ways to address social potentials and challenges that can overcome some of the fundamental and critical challenges. As an example, knowing the political and cultural forces that produced the civil war in Beirut, it's interesting to note how [and] when it came time for reconstruction, it made more sense initially to develop the cell phone system because war could have broken out any day after that. And so they had a better developed cell phone system prior to the United States at that moment in time before they invested in landlines. The way in which cell phone systems in Bangladesh have been adopted to reinforce not communication, but the economy itself for people who are absolutely disenfranchised – beginning to imagine that technology that is simple, that is economical, that is accessible, and that is the platform for creativity can be used for inventive purposes and, if you like, amelioration of social circumstances . . .

Interviewer: You said technological paradigms that influence or shape social structure have that power, which is economical concerns as well. On the influence of technology-technological paradigms on the social formation and culture of the architecture schools, how are digital technologies and their associated paradigms changing social structure and culture of the architectural design studio of this school?

Nader Tehrani: Fundamentally I would say that traditionally schools of architecture were rooted on representational media. Now – because of the influx of access to technologies as a convention – digital platforms, digital software, digital hardware [are] now producing the conditions by which we can simulate performance criteria for architecture. So now we don't learn how to represent buildings and then enter the work force and then build them. Now we build differently in school in order to change the industry. So, it was top-down driven before; you would prepare people for the practice by making them learn how to draw pictures of things. Now we invent the processes of building in such a different way through the actual exploitation of technology that we do as students to change the way that buildings are built out there in practice. Meaning that you're making the elders obsolete, by the way, so this shift is a critical shift; the technological shifts both in hardware and in software.

Interviewer: And we're talking about MIT then trying to shape the practice?

Nader Tehrani: I would say that in general, but MIT can lead because it's so central.

Interviewer: About 100 years ago academia shaped the practice. I don't sense it at the moment—

Nader Tehrani: No, not completely true. There are a lot of the grassroots interesting projects that you see built today that are the result of architecture students going out there, setting up labs, building for other architecture firms, and building extraordinary things. But they're not fabricators; they're architects. And then other fabricators start to compete with them, and the supply and demand of a certain economy changes, and then the discipline changes. First – like [a firm or an architect] that started as skin, then went to skin mechanical systems, and then fabrication systems – all of a sudden become integrated systems firms. So it changes the way that design studio changes. It's not about form. It's about performance; it's about integrated thinking. These are many ways in which problems of visualization and representation have been displaced to engage questions of simulation whether it is for environmental structural purposes, or whether it is for fabrication purposes.

Interviewer: How it is at MIT? How's the culture, how do the students interact with each other? Did technology change that, the traditional way of interaction, the traditional way of studio organizing?

Nader Tehrani: We have limited space. It's chaotic like in any other studio space, and I suppose the one thing that is not about MIT – the digital medium has expanded your community. Your buddy next door is teaching you how to do something, but you're also getting a tutorial from some kid in Arizona or some kid somewhere else, so the kind of open-source idea of education is changing, I think. It's also less hierarchical; it's not your studio teacher that teaches you. We are there for certain purposes, but your TA and the kid from Maryland is also doing this other thing. So, how we learn from each other, how we learn from the Internet and other vehicles is pretty significant.

Interviewer: What social modes/organization do you see in the design studio?

Nader Tehrani: There's many. There are design-based things, which are quite collaborative; there are design things that are very research-based. You actually have to do scholarly research, technical research, performative research. There is no substitute for independent, autonomous, and individual work. That's part of your responsibilities also. And finally, in advanced thinking the notion that architecture, the discipline, is something that you can impact from the bottom up, meaning how you build, the procedures and the parameters that you construct for buildings are as important as the artifact itself. So, systems thinking do come to be interrogated by that kind of activity.

Interviewer: [At] some schools, I see, they [use] agile organization where a student has to change—

Nader Tehrani: It's not an uncommon model where you set up a rule by one student, but a different student has to implement that, and the rules set up by this person have to be adopted by that student, etc., etc. But I think there are different pedagogical models. Technology did not need to do this. You could do this purely on an ideological basis. Imagine you do an organization of a site plan, but you're forced to abandon it and give it to me, and I'm supposed to do that to her. So that's about critical thinking, like when you are in a debating class where you're forced to take a position, not because you believe in it, but because you have to think of the rhetorical foundations of how an argument is constructed. The technology may impact it, but the pedagogical model is not based or rooted in technology.

Interviewer: Do [the students] help each other out? Is each one of them working individually?

Nader Tehrani: Collaboration involves the understanding – learning involves the understanding that you almost rarely get to succeed at what you're doing while you're learning it. It's always a process whereby you're failing and succumbing to challenges and hurdles that you can't overcome while you're doing it, but as you look back on it, you begin to test out the potentials of what you failed at the semester after, or the year after, or the decade after. Collaboration in turn involves the tolerance of ideas greater than your own, techniques greater than your own, but the ability to find both negotiative paths where the sum of two people is larger than the parts, but also understanding that not everything is valuable – some things are not valuable – and so that you have to fight for certain conceptual rigors. And in that process, one or two collaborators may get thrown under the bus because conceptual thinking involves rigor. So, it's a tough thing, and some kids get brutalized along the way. Some people get lazy along the way; some people get bigger egos along the way. And arguably because practice – look at this, everybody sitting there. Do you see the principals? Can you see the interns? You can't see it, right? Because the lowest of the lowest and the highest of the highest have to demonstrate their value through what they do, not because they're walking around with a stick. And in studio it's very much like that.

Interviewer: Do you see a trend, Professor? What do you see is leading in the next 10 to 15 years in the studio?

Nader Tehrani: Collaborative learning? Definitely the trend has been on the upswing because we've come to realize that you don't work alone. So the idea of simulating collaborative processes, not only among designers but among other disciplines, can only advance a richer, deeper – it's an argument about breadth and depth. You're wider among disciplines, but you're also deeper in terms of knowledge sources, so that has been quite helpful. Not every curriculum has been able to figure out how to best do it, so it produces chaos. So, simply said, it has been a process of figuring out how do you work with people because it introduces variables.

It's a little bit like acting. When a director has a very clear agenda for a movie or film and they have a script, if the script is good, the actor is engaged with it in very inventive ways, but often both producers and directors instigate a working process where improvisation, interaction, produces synergies which could not have been produced by script but could have only been produced by a scenario. So a lot of scenario-based design produces these kinds of synergies among students that is much more inventive than the scripted narrative that a professor instigates from the top down. So you have to begin to imagine that the curricula now are research-based. They open up avenues which would not normally be opened if they had been so constrained.

Interviewer: And what would you think about the future. What do you predict there will be change in the – if we reach this right now, this is what's happening, what next?

Nader Tehrani: I think that what has been achieved in the last years is so expansive and so broad and is so amazing, actually, what has been lacking is specification. The bigger question is: how are you able to educate people to be expansive and focused and microscopic at the same time? The people that are working at the cellular level rarely have the panoramic vision, and the people that have the panoramic vision rarely have the microscopic. I can only speak ideologically at this point, that I am invested in reconciling those two lenses because I think that arguments are only interesting when they find their results in specification. And so the challenge in the future will be, to some degree, how you can broaden the boundaries of the discipline, but within a very specific context? The what is not always interesting. It's the why; it's the how.

Interviewer: In teaching students to critically engage the use of technology in the design studio do you teach students to critically engage and question technology/technological paradigms within the design studio? How so?

Nader Tehrani: Essentially you don't accept software; you write software. When you teach computation, you're not teaching them how to use the software; you're teaching them how to think through codes and write their own codes. That, in part, is what critical thinking is; you generate them. When you're thinking constructively, you're not thinking of how to design a building; you're thinking about how the means and methods of fabrication change the way the building looks because of how it's built, not because of how it looks. So, these are just two examples. There are many ways in which technology is thought through critically. It's by contextualizing, it's by interrogating it, and it's using it as a medium for interrogation.

Interviewer: Some students present the Grasshopper definition on their boards. I'm questioning 'Is that a critical thinking of the use of that program?' I would rather see reasoning in that Grasshopper definition diagram into sketches or so—

Nader Tehrani: You have to be careful because the way I'm answering all of my questions – it's always motivated, it's always directed, it always attempts to be reasoned. But another mode of learning is that you just do, and you just do. And the cummulative result of arbitrary marks and tests, which are unmotivated, filters quality or motivation out of it. So post-rationalization is as valuable as premeditated thinking. And if you don't have that openness to learning, then you're not giving the generative processes a chance to impact you. And this is probably the way in which intuition and reason can begin to dialogue with each other.

Interviewer: Think of the third one. Do students think critically about how these technologies affect architecture representation. Do you see that with their projects? How is that? What do you see in their projects that shows you they critically think about using these paradigms?

Nader Tehrani: Good students, yes. Well, I mean, obviously digital media has expanded our means to representation. What we used to do in film, which was never adopted in architecture, cannot be done through animations, so notions about motion have become integrated. Animation and motion have become integral to the architectural presentation. Issues of sound and the sensorial nature of the environment and the interactive nature of the environment has become central to it. So, notions of representation and simulation have become involved with each other.

Interviewer: How might social responsibility evolve in the future in relation to technological advances?

Nader Tehrani: The question about social responsibility has to do with medium. What can architecture impact through its devices, and what can it not? How you vote in a polling booth is different than how design impacts the environment. I think what we should be discussing right now is agency of architecture: In what way does space form material iconicity? The performance of the building impacts society and not to overrate that. Things are quasi-autonomous.

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architecture representation?

Nader Tehrani: I would say the majority of the young faculty, yes. The older faculty have a slightly different challenge in dealing with those things.

Interviewer: Is it a generation issue?

Nader Tehrani: There's definitely a generation issue, but that's not across the board. There's some people that are changing with the times and are really thinking through these problems very critically.

Interviewer: So, why do you think they're not adapting? Is it a belief or—?

Nader Tehrani: Why are some people not adapting? Some people are stubborn and some people are intellectually quite open. But it really is like that.

Interviewer: Skeptical?

Nader Tehrani: No. Yes, you have your skeptics. You have your lazy people, but you also have people who are genuinely interested in the potential for architecture to change reality. And architecture is seen both as a conceptual endeavor and as a disciplinary endeavor, or a practical endeavor. So, in so far as technology has the ability to evolve that and transform that, they are engaged in it.

Interviewer: What are the opportunities these technologies offer, and what is lost by their use by a faculty member?

Nader Tehrani: Well, good faculty see design as research. In so far as technology has the ability to expand one's analytical terrain, transform, extend the way in which something can be understood, all of the faculty, in one way or another – whether you're dealing with an illustrator or with scripting – have this ability to imagine that knowledge is being produced. Maybe what is more important is to recognize that in schools you don't get knowledge; you produce knowledge. And so, faculty recognize the ability with which technology has the ability to produce new forms of knowledge that once could not have been had using the same medium or a different medium.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Nader Tehrani: You mean our budgets, the fact that we don't have a strong economy in our school?

Interviewer: Yes.

Nader Tehrani: Yes, for a long time we didn't have a fabrication lab. We didn't have access to software, so we had to create the conditions by which we could receive those.

Interviewer: Was it pressure from the profession that affected the way in which you school has adopted—?

Nader Tehrani: No, not the profession alone. The profession we believe is still behind us.

Interviewer: So what was the reason that you worked to get that fabrication? What was the reason for you to do that? Why do we need it?

Nader Tehrani: I'm interested in a couple of things. I'm not interested in theory versus practice. I'm interested in the way in which theoretical constraints, concerns, can be channeled through practice, and then [I'm] interested in the way in which practice challenges theory. And I want to theorize practice. In so far as that interests me, architecture remains for me many things; among them, a dedication to building practice is an important one. But building is not a static process; it's highly evolutionary. And the way in which we build today is so different than the way we built even ten years ago. So we now need to produce new forms of knowledge, and we cannot be held hostage by practice as it always was. We have to produce new forms of knowledge. Technology helps us to do that.

Interviewer: Was there an ethical reason for you? You don't want to graduate students that don't have expertise in certain areas?

Nader Tehrani: It's not so much expertise. It goes without saying that you want to produce the best students, the most cultured, the most technically advanced. I think you want to produce students that think critically because the technologies that they learn in school will become obsolete within five years after they graduate, so they have to actually be trained to think in a way that is adaptable to new forms of knowledge, new forms of technologies that are emerging. Well, you're too young, but in my generation when they were teaching AutoCad – it's really obsolete. The way that we draw now is different. So learning AutoCad is not a goal. Learning the constraints and mechanisms of thinking in AutoCad makes you more adaptable for learning other kinds of visualization tools and processes.

Interviewer: Professor, through the stages that you told me about, starting from geometrical studies, than go[ing] to an advanced [studio], all the way to electronics and programming—

Nader Tehrani: . . . There are other seminars – design architecture and engineering, for instance, that's critical because [of] the performance software that gauges structural feasibility, morphological concerns of structure, and materiality – and then we build them. There are other ways in which this is done too.

Interviewer: . . . Some schools teach them texturing, 3D studies, drawings, shade and shadow, abstract thinking before we go into the use of tools—

Nader Tehrani: Actually, we do it in both directions. We do a head-on collision. Some things necessitate abstract thinking; other things require an unmediated and brutal relationship with building. So, if generically architecture was thought to be abstract and then it becomes more concrete as it goes into plan from which a projection of a section emerges, and then an elevation, and then you zoom in on the details – that's purely an arbitrary way of thinking. It's a linear way of thinking. Why can't you develop a detail and from that an entire building emerge? So what we tend to do is we make forms of learning and generation interactive, multi-scalar, and non-linear, and conflicts occur as a result of this where you need to then make decisions about what the best path is.

Interviewer: What do you think are the most pressing questions/issues regarding the relationship between architecture education and advanced technologies in the design studio environment? In the way they teach design?

Nader Tehrani: Broadly speaking, a challenge I would put out there is: to what degree can architects, as thinkers, reclaim their discipline from the shackles of outsourcing all of the platforms of thinking, which is necessary for design process? To what degree can we re-own engineering, structural engineering, environmental engineering? To what degree can integrative thinking come to characterize the way in which we master the medium, take control of the medium? Among that, budgeting, financing, and the economy of the building are part of that. I'm not trying by saying this to kill the collaborators with whom we're commissioned to work, but rather trying to provide tools and mechanisms, via technology, so that we can have a speculative relationship and not merely just a receptive relationship to those disciplines. If our ability becomes more expansive, we can own, we can challenge, and we can generate a more thoughtful relationship with how design impacts space, society.

In other words you don't wait for specialization or specialty consultants to do the job for you. You have this ability to orchestrate relationships between them that is larger than the sum of their parts . . . But the notion that we're orchestrating complex relationships between things – specializations only think of one thing at a time. We are thinking of multiple things at a time by definition.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Nader Tehrani: Actually, I think you've been very, very thorough and very expansive, and you've been very meticulous in the way that you've broken down all of these things. I just apologize that we had to break the discussion into two halves and I was so late in talking to you.

Interviewer: No, I understand your busy schedule. Thanks!

13) Omar Khan

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school (University at Buffalo School of Architecture and Planning)?

Omar Khan: Absolutely. For us, digital technologies are a large part of how we imagine architectural education to take place. Our interest on a pedagogical level – our school is heavily invested in learning through making. We come out of a tradition of craft as well as engaging in materials. So, while that doesn't seem to translate very quickly to digital technologies per se, what we have seen, is that digital technology . . . its relationship to architecture has really moved away from the screen.

In the late '90s and maybe early 2000s, the screen was so predominant in terms of the mode in which digital technologies were engaging architectural practice. It was heavy on representation for a school that's based so much on the kind of learning through making craft and so forth. The big influence really was when digital technologies moved out of the screen, and those are in few different places. For one, it was in CNC machine and so forth. So, when you began to enable the tool and create new tools, laser cutters to 3D printers to CNC machines, we started in our school incredible growth of engagement by everybody across these different platforms and years.

The other part was really where I came from, which was the specializing of digital technologies, smart systems, and interactive and responsive environments. Now, I brought that to this program, and we built a program around that. And there is really [an] interest in terms of physical computing and thinking about computing as an embedded system.

So, on the most kind of basic pedagogies of architectural education, we are invested at the moment, right from the beginning. We get students started working with computing very early. But we are really integrating the computing part . . . so computers as a means to consider materials thinking, computers as a way to rethink environments, as now computing is design[ing] our environment. So, that's really thought about, smart systems and so forth. Coming out of craft traditions, we see that a lot more in our [studios]. As students are making things, the quality has gone up because we have real access to 3D printer, laser cutters, and CNC machines.

Interviewer: Does your school at the University at Buffalo use one technological paradigm, or is it a mix?

Omar Khan: I would say it's a mix. We use a term called situated technologies to describe a very particular part, which has its tradition tied to cybernetic and systems theory, right? So, they are in information systems. But that's one side.

The other side is digital craft, and that is more tied to the formal expiration that digital technologies make possible. Let me just give you a little example of that. A certain part of architectural education, for instance, that deals with form and form making has its roots a lot in geometry and geometrical manipulation. And computing opened a whole new area in that direction, right, from NURBS (Non-uniform rational B-spline) modeling, solids modeling, and so forth. It made that quite explicit to that whole process.

That whole tradition of kind of geometric manipulation, geometric play, understanding geometries and their relationships and so forth, that computing brought it to the forefront. We have a tradition here at Buffalo of people who came out of the old school that mainly were invested in graphics and geometry and how geometry related and so forth. But they were doing no computers; they were used to the old way of drawing and making complex geometric transformations and that kind of stuff. Of course, when computing came, that stuff began to become scripted; that became things you could do very easily. And so we're building still on that tradition, but it's heavily based on craft and making and so forth. So, those are the two traditions, I think, paradigms we sort of [sub]scribe to.

Interviewer: How are they integrated into the curriculum?

Omar Khan: In the past computing was something you did after your junior year. We have an undergraduate and a graduate program, and in the graduate program the assumption was that if you were coming here for a two-year graduate program then you already had computing in your background, so you get in particular courses. But if you were a three-and-a-half program year student, again in your second year, you would learn computing.

Computing was requested as a kind of delayed later part of the education. In your first part of education was the formative basic design, more based on drawing, construction, of a constructed drawing, using the mayline (drafting table), and constructing perspective – constructing axes and all that kind of representation.

Now we have a totally different setup, and this is really technological. We have tied to every studio a media class. And in the media class every student – this is from the freshmen studio, [which] has a media class. The media class makes no distinction between analog and digital processes. It began to introduce both simultaneously. Freshmen [studio] is a good example as you're learning how to draw for the first time.

The line becomes significant, important, because the line begins to define boundaries. Well, the line is very different when you draw it, and the line is very different when you do it in a computer . . . When you take the line, what does the line mean when it is laser cut? It's the same line; it's now transferred to now becoming a cutting instrument.

It's a simple framework that you can work with. But this is the first semester that you come in. And you go through that for your first three years, and the undergraduate program every semester improves. That's when you move from basic line drawing to geometric modeling. By your second year, you're doing NURBS (Non-uniform rational B-spline) modeling in Rhino. The second semester of that is more in representation; since you're a sophomore, second semester is heavy on representation, ray tracing, those kinds of things where you really look at how light affects the model and so forth.

By your third year, you are working in Grasshopper and parametric, and by the end of the third year, your second semester, you'll be able to perform Eco-tech, so a performance-based analysis. So, as you can see, you start with just modeling, and you move the model into kind of representation and then from representative to performance. And that's how we layer it.

Now, in our graduate program it's far more sophisticated because now we're in areas like situated technology research group. Their technical course in the graduate program is physical computing. We teach electronics, Arduino electronics (an open-source single-board microcontroller), scripting in Arduino, interactive systems, how to use your scan sets with your data sets and so forth, as well as other groups that maybe deal a little bit more with performance-based, so ecological practices in other groups.

Our graduate two-year program is organized around four groups. There is a group called Situated Technologies and a group called Ecological Practices (Sustainable Urban and Natural Environments), a group called Material Culture and a group called Inclusive Designing. Each one of them has a technological component. They teach a technology class every semester. Situated Technologies moves more and more into interactive systems. Material Culture is more in fabrication. Like plasma cutters, CNC-run plasma cutters, routers, sophisticated geometries . . . so, we are very invested in these technologies, but as you can see they immediately begin to be specific too. We don't teach technologies for technology sake; they are really tied to very particular intellectual agendas.

Interviewer: What do you think are the positive and negative implications of this, the use of technological paradigms?

Omar Khan: I have heavily invested in moving my school towards working with these [technologies]. Two paradigms that we are working with – one I call the digital craft, the other I call situated technologies – both of these open up new modes of production design and new modes of the engagement with the environment.

They are very positive influences in terms of what architecture is, how you make architecture, because it's heavy on tooling, but how does architecture change, mutate, because if you have a sensing environment, it's a very different way of thinking about architecture, not as a stable verified form but as a form that's mutable, changeable advancement. What are the problems? They both carry with it two problems.

The digital craft part, if you over emphasize the technology and it becomes technologically deterministic, you will lose certain types of skills. One skill that the student [is] losing is the ability to draw the hand sketching, and sketching is a unfortunate loss because if you can sketch, it's a language. And that's something that architects have always done well; when we talk, we draw, but when you are used to using other mediations . . . you have a program within which you have to think in order to get the output.

Now, that mediation sometimes makes that immediacy of conversation not possible. And that's the real problem unless the people are super conversant, and many times they are not. I don't read a script; I can understand what the script is doing. I don't read a script, but I can read a drawing, being with intentions and stuff. That immediacy is lost. Now, I think there are ways of changing that, but that's one of the big problems that we face where students are not capable as much to draw their ideas; they need to use a mediated device.

In the other part, the situated technologies, the danger there is the loss of the object. So, if everything becomes mutable, everything is based upon contingency of sensing. Then, sure, you lose a little bit the kind of constraint resistance that matter gives you, right? And this is where I have some objections in systems thinking because if everything is a system, then you have a tendency to abstract more than stick with certain more permanent things like materiality.

My concern with a lot of the systems-based work is that [it moved] away from materiality. We are actually losing a very strong aspect of what architecture does, which very few other professions or practices do, which is that we inscribe and leave artifacts on the environment, and those are important because it's around those objects and inscriptions that things organize themselves. And if we just become very abstracting and organizing and not actually investing in the making things, we can lose that.

There are certain losses. People don't know how to draw perspectives, and more people don't draw axonometrics because you can pop out an isometric in a software. People don't draw plans, sections – there are lots of things, ways of architectural thinking, that we used to do, that we are seeing less and less. Most kids do model; they start with a model, and then they derive plans and sections, totally the opposite of the way I was taught: you do plans and sections when you derive the model, right?

. . . When they look at a plan, they look at a plan in a very different way than I remember when I was taught to look at it. They look at it as a slice of their very complicated model, whereas for us it was a way to build up a larger model and has a very different meaning. So, I think it's changing the conversation. Is it making better architecture, or worse architecture? I don't know. I think the jury is still out on that. Clearly it makes [things] much more complicated looking and geometrically more sophisticated in terms of architecture, but my hope at the moment is that we can maintain – especially with the background that our program has heavily invested in making and doing – and then we could maybe solve it . . .

Interviewer: Professor, do you think there is a way to bring back what we lost, for example the hand sketching?

Omar Khan: I think it will become more integrated. I think the biggest problem right now is that the interest in what computing allows now is this ability to breakdown the complexity of what is a piece of architecture; give every piece its voice and have it play out. Whereas before you are always moving towards the object in the design process, here you move to possibilities, you know.

If it's in Grasshopper, and you play with the input dial, it becomes something else. This kind of mutability in some ways is very powerful. You can see sketching in a very different way at which certain kinds of possibilities are laid out. The difficulty there is: how do you choose which possibility is better or worse? What is the basis of that choice? And that's what you lose. You create the tools for choice making, right, because now I have made numerable different choices that I can make in terms of what my design would be. But I don't have the judgment by which I can make that choice, right, or I have to choose something based upon something external.

The other process, the process of sketching, was always a process refinement, and so therefore it's like a negative feedback. It was always moving towards a particular goal, whereas a lot of the work that we do now in computing, it actually has this positive which opens up more possibilities than necessary.

Sometimes I find with students because they are still learning, they don't know what is better. This question of what is better or what is worse is much harder to make judgment calls upon in these kinds of environments, like scripting, than it was when you were tied to some basic notions of, 'okay, this is my concept, and this is what I am trying to get across.' Those kind of strategies are shifting, and whether or not you can get sketching back again – I think on an instrumental level, yes. So, you know, we have styluses drawn on the computer and so forth; that's already happening.

In fact, I have a very good student who is working on the sketching, a very interesting sketching program that ties to your biometrics, the pressure by which you push and so forth. All that feeds into the computer. And that's very interesting because it reveals a lot about the way you sketch and the way you do sketching, so it becomes very reflexive. I think those kinds of things are there, but I think what we are losing is judgment. How do you make judgment? And I think making judgment was much easier when these tools weren't there.

But this is not a bad thing. Before, judgment was made by which school you went to or who taught you, and so in many ways you are very strongly alternative in a particular way. Now, with the parametric environments, even though many of the stuff looks all the same, there is this notion that you have more variety, but it doesn't help create the judgment. And I think that's more a philosophical and conceptual problem than technological.

Interviewer: How do you believe technological models shaped architectural pedagogy historically? What did it add to the critical thinking of design?

Omar Khan: I am a believer in architecture as an idea first and foremost. I think it's out of those great ideas, strong ideas that good architecture comes . . . The technology on an ideas level is the important thing not so much on its instrumentality and its capability.

There is a lot of work right now which is strongly influenced by technological progress. In other words, you use a new program now or you use a – 'oh, look, I can render with this thing, or I can model with this' – and that has a very short life, and we have moved through a lot of those in recent history like Maya, Form-Z. Right now it's Grasshopper. And so we work off from these instrumentalities as if these instrumentalities are the idea, and unfortunately that's not true, but they produce the sexy images. That's provocative.

When you have a CNC machine, right, you have three axes, but it's not as cool as having a robot arm, right? A lot of it is tied to this affordability and yearning for the new and the latest. And technology has a tendency to be that, and maybe that's its basis, and so I am just waiting to be part of this community now for a while just waiting for the next [shoe] to drop. But that's my concern, and that's my critique of it.

Its fundamental critique is that when it's just about the new technology and technology becomes technologically deterministic. It's when technology leads to informed ideas, how we think about it, this idea that architecture can be unstable. Well, technology allows us to think about it. The fact that architecture could think or sense, well, technology allows us to contemplate that. I think those are very, very productive things that can self-organize, right? That comes out of technological thinking but also biological thinking.

Other things that can be various – these are maybe more philosophical but they can be practical – how understanding, let's say, complicated technologies now, how a building changes its shape in order to optimize itself for energy or something like that. Like, those are things that are fundamentally made possible by the technologies and how to think about those because we have now the tools to think through those.

But, if you don't have those ideas and then you have arguments, how do those ideas then reflect on society and economics? It becomes much more intriguing. That's why I like being at a state school as opposed to a private school in some ways, because this environment focuses us on that social and economic reality much more than, let's say, private school, where you can be very much tied to the latest gadgets because you are in a competition to be that. And I don't think that has a long life because you have to constantly change to keep up with it, but then it doesn't have a tendency to bring ideas that can be lasting, and that's what I am interested in: lasting strong ideas. And I am not pretending that we are creating new ideas; we are transforming those ideas that have been around for a while and thinking about them in new ways. When technology allows you to do that, then it's profound.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? How?

Omar Khan: Yes, I think we are far more technologically engaged than we have ever been, partly because our communications are now tied to these digital technologies in a way that they weren't before. How will they change? You are going to see a few interesting shifts. First of all will be – and this comes out of more like social media and that kind of affordance – you will get a lot more voices in the production of things, and therefore this question of expertise begins to become a little bit more questioned.

Opening these technologies now – making it much quicker to scrutinize questions, deal with issues –will change the production of architecture and stuff, or the perception of architecture. As these advances happen, one of them of course remains. We have come to terms with the fact that intelligent systems are not big AI, which was this idea that you had intelligence harbored and, let's say, a computer that could be mimicking a human brain or something.

This idea of a big human or big intelligence that could control everything disobeyed, and we've come into some much more interesting models. And this goes back to this model of the social media, where intelligence emerges from a lot of different kinds of ways and interacting in networks. Intelligence is more networked as opposed to centralized, and these networks will open up interesting possibilities for the way we may think about the relationship of objects to environments, objects to other objects, environments, separate environments to other environments, because these things begin to get connected now in ways that previously they weren't.

What we are going to see is that we are so connected . . . Yes, we made a building; it dealt with its environment, but it had this interiority. Its interiority could be completely separated in many components. I think we will move more into a world of such hyper connectedness that those boundaries are not so strong anymore. It's in a sense [that] you have an understanding that boundaries are now more permeable.

You will get much more architecture that will represent that permeability. We will get the filigree you see a lot, right? Lots of patterns and things, very open. You will get kind of very coarse walls and things like that. So, inside, outside will emerge, or you will get the kind of retrograde idea of real separation, ways of separation. How do you separate? And so, you may get another pushed that way . . . There is this connectedness that people are perceiving, and they perceive that architecture doesn't do it, doesn't connect in the same way to see the environments of a custom.

This is an increasingly interesting technological shift that is influencing our status quo but also our notion of what architecture is meant to do. And I see that in the next few years, unless there are some other kinds of catastrophes. All this question of security is retrograde where you see the tower that they are building down in New York. It's a glass tower, but the bottom of it is [poured] concrete, and it's [a] relationship of complete permeability, transparency, openness against total impermeability . . . The economy is going to be very strong there because we have seen that in our technological systems as well. Heavy on security, heavy on encryption, yet everybody can use it in this concept.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

Omar Khan: So far I think this performance-based design is going to become the means by which people will evaluate, commissioning design and so forth. I think you are seeing a shift away from – even the architects who are committed to very hideous products – pushed towards a formalism. And strong formalism [architects] are now casting out, green washing their work or, you know, trying to find a way to make their work more performative, right.

. . . You are going to see lots of codes and legislation that's going to come around. So, LEED, Leadership in Energy and Environmental Design, is one beginning, but there will be so much more that will happen around it, and this is maybe for those people who are afraid of architecture opening itself up too much.

That's going to be demanded by clients. Clients are going to require these, I mean, even things like 'is this thing recyclable?' So, sustainability is going to become much more profoundly clear. I want to use the sustainable, recyclable material. So, there is all that social consciousness which really infiltrates. So, performance-based design [is] very strong. And that's, I think, the big shift in . . . 2, 3 years . . .

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

Omar Khan: What I am seeing increasingly is that, first of all, there is far more digital savviness, so people come here not to learn computing because they do computing. That wasn't the case as little as six years ago; some people didn't really do much computing. Now they do computing, so everybody is on Facebook and so forth. So they are comfortable in these technologies. They are comfortable in information and behaving with information in particular ways.

There is more demand from them as they learn about new tools to have access to those tools, and this is one of the big interesting shifts we are seeing in terms of the relationship between faculty and students, where students are far more capable of using these tools than faculty are . . . Before you see there was a skill that the architecture teacher had that was greater, so you taught your students how to draw. You taught them how to do these things.

Now the students are drawing and can manipulate things on the computer that most of the faculty don't know how to do. And [that] makes it much more inaccessible for the faculty in some ways [to] critique changes. You can't critique in the same way; you can't be discreet in the same way. So there are fundamental shifts in the way people talk about architecture, right? You're really hands off now in conversation, so talk about that, as the use of drawing. Why? Because you are not comfortable. I am comfortable taking somebody's mouse to draw something maybe in Rhino, but it's not as fast as I would draw if I drew with my hand. And so there [are] all these kinds of mediation that have changed that relationship . . . What is good about that is that in some ways it doesn't make the teacher the harbinger of all knowledge. And this was, I think, a particular problem also previously of the mentor and apprentice – whoever the studio master was and then the student's just an apprentice.

So there is a little bit more equalizing, but it could come with its own problems . . . There are new tools available, and out of those tools comes greater quality. So in our school we push, for instance, 'okay, now you can laser cut.' Alright, that's fine, so now you get incredible precision in terms of edges and all that. But that forces them to make sure that their assemblage is precision. You get models now that are of such high refinement and quality, and so I think that has also shifted quality into another level. In some cases, people are trying to work with digital technologies to make the work more messy or less refined . . .

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Omar Khan: On the one hand collaboration is very large, right? Because you can move information much more quickly. You can share things that you are working on; somebody else can start working on what you are working, right . . . shifting, I think, towards definitely team-based potential. You have to be careful there because I still believe in the authorship, and I believe in certain kinds of resistance to that. If it begins to be simply [that] everybody is a system engineer, [then] there is nobody who has any real accountability and ownership if something becomes problematic.

Collaboration is good, and working with diverse teams is good; that comes out of this mutable representation, but it can be problematic. Talking about the organizations in terms of schools, whether the schools are becoming more agile or hierarchal . . . because we will be relying more on the web . . . does make you more agile. Why? Because you can change what's on the web much easier than you can retract documents sent out as publications or as these things.

It all depends on how people do it. I know there are schools that [are] very strongly against being heavily invested in the web and so forth. They want to hold on to that kind of material object of architecture. The material object of architecture makes you aggressive in terms of your ability to shift and change things, losing one of these kind of hierarchies; then I think [it] is a problem.

There is a shift in the way information is being projected by these organizations, which makes them more agile and which opens up new possibilities because now you don't have to sit down and figure out your narrative before you say it; you can say it or you can project it and then construct your narrative . . . I think people are less invested and hold anyways, and so it is opening up democratic methods of engaging faculty in administration.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Omar Khan: I think in general they are positive. They are positive because of sharing. They are positive because we make sure that students are posting – we use a blogging system. So, when I run a studio, everybody posts every week, and this allows your peers to know what you are doing even though you may not be able to share with them. Well, of course you are in studio; the studio environment allows for that. But sometimes for a student to be able to say, "okay, this week I did this, and this is what I am interested in," allows them to do with this kind of reflexive thinking of their work.

In general these web-based technologies opened up communication. The other technologies, for instance the fabrication and competition or, let's say, design technologies, [are] making [it] much easier to share the work. You can output things and share them much more quickly. The problem there is not in the sharing; the problem in there is in the judgment, and that's always the problem you see, where[as] previously, because you were so invested in what you were doing, you never shared as much. You had a much clearer judgment of it. Why? Because you have to make a decision; you didn't have lots of inputs to that decision making.

Now, not only do you have lots of inputs because what you are doing is much more public and your peers are commenting and saying things about it, [but] that opens up less judgment on your part or more questioning on your part. And secondly, the object is mutable, so the tools are making it not so easy to make a judgment . . . This is the difficulty: judgment becomes much harder, and therefore you have to be very sure about judgment, whereas previously judgment was made very early on, and it was just a way to verify your judgment. Now judgment comes very late in the game of design, and that's a bad thing many times.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Omar Khan: I see a trend towards people having some clarity of how to create judgments in these environments . . . These parametric environments are little bit too techie for many people; they are not as easy, so you have to think in script terms . . .

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Omar Khan: So, if we are talking about technologies in general, then I don't think digital is the only thing. So for instance, in our third year of our undergraduate program, it's organized around systems. And by that I mean not only the systems thinking but about environmental systems, structural systems; these are all technologies of architecture, closed systems. And so when a student previously may have in the semester before worked more on historic precedents, the next year, the third in the junior year, they would be working more on how systems begin on the basis of design, and that influences a lot about how to critically engage technologies because if you are trying to think about how technologies influence your design, you have to critically engage with it. That's talking about the building technologies as the larger compound.

Particularly digital technologies, I think it's harder to be critical of those right away. I think their incredible power is their empowerment. They empowered students to do these things, so they are not critical in that sense. The students just work with them. They do it, and in fact, I think it's a good thing. I don't think you have to be critical about instrumentalities. I think you have to be critical about ideas. But I have the tendency – should I use this tool? I mean, there are many times you will be in the conservation, and the faculty or somebody will be sort of trying to scrutinize whether it was the right tool to use.

And I think that's not very productive because if you are critical of your tools, you have to second guess and stuff, then it becomes very heavy handed, and I think that's not the nature of these tools. That may have been the nature of some other modes of representation, but not the nature of these tools. So, I think we are not critical about the tools; we are critical about the ideas and the way those technologies influence the design of architecture.

Interviewer: So we're looking for the reasoning behind using these tools. The whys.

Omar Khan: Yes, that's right.

Interviewer: Do students think critically about how these technologies affect architectural representation?

Omar Khan: I see that in the graduate work. In the undergraduate work I see more exuberance, more excess, and more desire to try new things. And in fact, I am happy with that. In some cases excess is what's necessary at the moment. I mean, simply new ways of thinking about form, new ways of thinking about this, and it may be naïve. It may be not pragmatic, not practical, but nonetheless I think in undergraduate education my push is far more to be helping students work with these technologies to fulfill their imagination.

Criticality does come once you begin to start having real world problems or addressing issues that are far more engaging, and therefore the question of what technology and how do we use it begins to becomes far more pertinent . . . I am not talking about when I use Grasshopper in a critical way, or when I use Maya software in a critical way. I am talking more about the realm of surveillance technology, right? Or intelligence system. So responsive buildings or a new technology – how do you create new forms of architectures? You have to move beyond the kind of clichés of what these technologies are, and we try to help students think about those in a variety of ways.

Interviewer: When I attended some of the architectural juries at the school, I found that the sense of scale is lost in some of the students' work because they are thinking within their software environment. Some students present their Grasshopper definition diagram, and I don't see the reasoning behind it. Maybe they can do a diagram of their reasoning in using Grasshopper, step by step explaining why they are doing what they are doing. But their reasoning, I believe, for having the definition on their board is to show how that interesting/complex shape was created by that definition.

Omar Khan: The question of scale is a very important one, but that's when kind of formal exuberance overtakes embodiment of a structure. And that's where abstractions take over it. Is [that] purely exuberance as opposed to some kind of engagement to a type of new space? They are not properly integrated or properly scaled, but there are other kinds of interesting geometric investigations that are happening. Even those require a certain kind of imagination, but also far more gymnastics.

Buildings that have no relationship to context [are] not at all what I am interested in, that's one of the big problems of this kind of production because they are representing a kind of object totally divorced from scale of site and opening, typology, and all the other kind of stuff. But if there is geometric investigation, if there is kind of some rigor in terms of that, there is still something that would be otherwise not gotten because sometimes if you are being too cautious about scale it leads you to a very particular notion of what design should be and can be actually just as much determinants. One is a technologically determinant exuberance of form; the other, it is kind of context scale that becomes determinant… . We have to figure out what is the judgment that you are using to figure out what the determinants are. This is the problem with parametric; parametric is not parametrical because parametric means that there is something outside the system that influences the system.

These parametric drawing [are] the system itself. There is nothing outside the system; when you see a variable X changes and Y, those are the same because they are influencing one another. So, that's not something outside the system. So, many times the scripts are very internal, very kind of closed systems. That's more a theoretical problem that faculty have opposed to say, okay, now you know how to use this thing but what if you imagine this was this. So, open it up, open up that system where they can understand it in a different way – so that's I think, somehow, my concerns . . .

I don't have a problem really when it's about that because in some ways that is just passion on some level . . . Most of these scripts are also borrowed; they are not invented or written by the students. In the beginning you start with something and manipulate other scripts and other people's scripts – and that I think is a nice thing also that you are sharing this stuff – but the tendency with that if you don't have strong ideas then everybody will have the same project. That you see a lot.

But I would say it used to be the same before also. People will copy other architects' work. Oh, it looks like Richard Meier's building. Why? Because I would like the way those buildings looked. So, I give a little bit of leeway to students when they are trying to do those things because I know that it's a form of learning; they are going through a process.

Interviewer: What is your thought of shared authorship? Is it fine to borrow a script as long as the student built on it?

Omar Khan: Yes, absolutely. And I feel also that a script is fine, even if you use it, when you know where to use it. I think what is nice about these scripting environments is that it's very hard; it's just like now when you write a paper, it's very hard to borrow something without citing where did you got it from. Well, all I have to do is copy your text and put it in Google, and I know if it was a copied from someone else.

Scripts are similar also. People are well informed. This idea of borrowing and reworking, absolutely that's what makes architecture great. If everybody patented everything . . . then you wouldn't have this kind of work. So I like the openness, and I think the scripts are like that. They are there for borrowing and reworking.

Interviewer: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Omar Khan: Does it change the way we think about social responsibility? Yes . . . We are in a postindustrial city that used to be a very strong manufacturing city, but most manufacturers have left. We are also an international city; we are at the border of Canada. So, our problems are not purely American problems; they are regional problems. We share a large body of water, Lake Erie – that is shared by Canada. As well, lots of issues are about international commerce, globalization. You have some place in Toronto, which is incredibly diverse because immigrants, right? Buffalo is only an hour and a half away from Toronto.

So, we have very different environment where we are. It's not an environment that can be understood purely in terms of, 'oh, it's just a postindustrial city.' So technologies at the moment, I would say, are very interesting because there is a desire to reintegrate the industrial base, that which is mostly old. Let's say it's still a family-run business to a large extent; manufactures that started here and are still running their business need to retool, need to become more engaged. And the school is heavily engaged in talking directly with industry.

Then, by that I mean material industries, like terra-cotta, metal, concrete, glass, fiberglass, these are kind of manufacturers who make products. They don't just make the material; they make products. And they would like to talk to architects and designers to think about new ways of working and to help them think of new ways of working. Technology has a social impetus for innovation, local innovation, but also engagement is necessary. What's so difficult sometimes is how would you have a conversation with an engineer. Well, when your problems can be tied to technological problems, you can talk to engineers, you can talk to manufacturers. You can talk to many of the people.

We are a public university, and the question of what the public needs in the United States is a very interesting one. Why? Because our public discourse is so bad. Everything is about privatization, and when we talk about a public school it's always a funny thing in some ways because people don't understand the role that public institutions can play because [there] is such skepticism of an institution.

In that regard, we feel that our engagement with our public, which is our community here, is very important. And technologies make that possible from a variety of ways, you know. Yes, we could show off the incredible things we make. But we can make [things] in our community also, and that's another thing that we are doing. But it's radiance with these kinds of technological affordance. We are in Buffalo. There are lots of really good manufacturers, but as a school, we are the only game in town. The next school closest is Syracuse, right? But that's its own city, and the next one is Cornell.

There are lots of architecture schools here, but we feel that in the west of New York we can take a very strong regional position. So, social engagement – we used Buffalo as our laboratory, and that makes us very unique and different in the sense of our context is different. Buffalo is not like Cleveland. It's not like Syracuse, for that matter. It's a very different city, and if you can engage that, you can open up new possibilities.

Technology is a big part of how you can you engage that because when the public looks to us, they look at it as a technological giver, as a potential technological hub. We can teach technology. We work with new technologies; we can open up explorations and research into new technologies, which would be very difficult for practice here to do, which would be very difficult for industry here to do on its own. So this kind of ability to act as that kind of partner is very important.

Interviewer: How might this definition of social responsibility evolve in the future in relation to technological advancements?

Omar Khan: For architects now increasingly, relevancy is architectural . . . Internationally you see buildings are specific models of economics and social engagement, right? So you know, when there was tremendous money in Dubai, it was all about Dubai, right?

But that was tied to a very particular economic model. And yes, there was some very interesting buildings made there. When it was China, it was about China, and so you have these kind of stars architects. But also other architects were trying to engage in these types of making, and I think architecture is increasingly global for sure. There is this problem of the global economy that we know can't be sustained, and architecture is the first victim of it.

And we have to be careful how we project into this global economy. So social engagement may be about being much more local, but the local is no longer local; it's very global. Like I said, we are Buffalo. We are city of 300,000, but we are an international city; we have an international set of issues that we are dealing with. We are a model for many places that deal with border towns. So we can become a very interesting hub to study border conditions, border negotiations. We also have a large body of water. All these very local things that you could engage – not in abstraction but in direct ways, which are socially engaged, socially responsible – and that can feed into larger global systems . . .

I think the small problems are the big problems, and so therefore for social engagement, we have to be cheerful. It is not simply a matter of being moralistic. That's what you have to be careful of, becoming overly moralistic. But now architecture is not about form; it's about social engagement. But that's pity, that's a loss, if that is what architecture began to be about. Because they were back into the world of – as if we can solve the world's problems; that's even more egotistical than the formalist, where at least the formalists are basically saying, 'well, what architecture can do is make interesting form.' They can be inspiring. They can be beautiful. They can be all other things, you know, engaging, critical, whatever.

We are not the answer; we are one part of the answer. So, how do you deal with social engagement that doesn't give us this kind of inflated sense of ourselves but still makes us relevant? And this is the hard part, when everybody starts talking about sustainability in a particular way . . .

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Omar Khan: Percentage? I would say probably at our school about 30% deal with advanced digital technology, as you mentioned, digital parametric modeling, simulation, and so forth. I would say digital technology is about 95%. Right, so that means even things like simply geometric modeling, NURBS modeling, representation. We still go through a period where people are drawing on paper and mayline (drafting table) with pencils. But everything is done on the computer, so there is a heavy engagement in those tools that are out there. But advanced I would say is about 30% – and my hope is to get it higher.

Interviewer: What are the primary factors that you believe may hold back those 70% of faculty members who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

Omar Khan: It's a realm of ideas. At the moment it's been very much governed by exuberance of mutes. So, now they are strong ideas that are tied to certain kinds of things, but there are not enough people talking about it so it's still very techie. I include myself in it. We are overly techie people. Our society, ACADIA is a good example . . . But this is very much of a little club . . .

So we come out of that kind of tradition of archispeak (architectural terms), which is that there is our own little language and that separates us from something else . . . But I think that's changing slowly because as you get younger people more involved in it and these technologies are tied to real ideas that are relevant architecture above and beyond, that kind of specific concerns will change that paradigm, and the acceptance of it changes that.

Interviewer: So the issue of generation is a part of that?

Omar Khan: . . . I don't think it is generational. I think fundamentally generations bring new knowing, but the questions remains the same. Those questions, they were bugging the generation before us [and] continue to bug us. 'Why is this meaningful? What does this have to do with lifestyle? What does it have to do with our concerns?' Those kinds of questions remain . . .

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation?

Omar Khan: There is a very strong discussion going on the role of representation. What digital technologies have done is that they have opened new possibilities for what the drawing is. The drawing of a building would be the representation of what it would become or a semblance of it.
The drawing was an instruction [on] how to make it, so the drawings had certain kinds of representational capabilities, but now the drawing has other qualities. It in itself is something you can analyze, you can test using the drawings. So, this is where performance comes [in]. The drawing isn't just representation; it is architectural performance. The drawing is performative in a way it's never been before. You can talk about it in generative ways . . .

Now when I draw a model or build a model in a computer, I can run analysis of it. Well, we didn't do that with a drawing before. You didn't run analysis . . . This kind of system is sort of a drawing having that kind of quality. Sometimes people actually represent that analysis in the drawing, right? With that kind of the color fields like people use now, for showing, stresses, environmental concerns, and so forth, it is drawing that's performative and self-descriptive. It's shifting architectural representation in a way that opens it up in very bizarre ways.

The other one that I think is profoundly interesting is BIM, which would maybe outlast the life of the building, right? You design the BIM model, and the architect, the consultants pass to the facilities people, who then use it to maintain the building. And then when the maintenance of the building is gone, that model accesses the memory of the entire building. It process; it changes; it becomes its archive.

So, what lasts? The drawing lasts, right, in the material object. It's a curious thing, so the drawing is performative, and we use still the word representation . . . But it's representative in a way that's very different than previous drawings were because it has all this crude memory in it., which is really, really fascinating, [a] very interesting way of thinking of what a drawing is about. Faculty here are very strongly engaged in thinking what does it mean to be performative drawing, performative models as just representation models.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Omar Khan: Yes. Economics is a big problem for state schools, so we are just like every other state school. In the last maybe five years of it, budget cuts continuously and continue to suffer partly because of it, so if I buy a machine, that means less money for faculty travels.

. . . These machines and these technologies are means for us to change our economy also. Why? We can take hold of a particular setup, affordances, and instrumentalities within this community . . . And it's great that we are the experts; they come to us. So, we have the expertise. We have the knowledge. We have students who know how to do use them; our students go out.

If you are not buying, if you are not advancing, if you are not progressing, you are going to be left behind, absolutely. But at the same time, unlike a private school which has the ability to purchase these things, we had been having to be far more innovative. I would just give you an example. A 5 axis CNC machine costs in the market of $50,000. We weren't able to purchase one. And so we said we will build one, and we built it for $18,000. The reason we can build one is because we have skills that students have like coding. Students know how to do controllers, and we are lucky we have students who are particularly good at it.

And most of these open communities that exist online, you basically contacted somebody and they said, 'oh, you buy this part from here and there. And these are black boxes, and we connect them, and they work.' Now, of course, it took us a good year, and we've been debugging it. We built our own machine, and we use it. And so the economics made this possible. Otherwise, if we had the money, we would have bought it twice. So, sometimes these kind of difficulties will open new opportunities because now we have students now who know how to build CNC machines – these students now are running what is called CNC boot camp. So, they do this, and it's like a hobby thing. So students are making their own CNC machine, three-axis CNC machines . . .

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Omar Khan: Yes. There is a desire everybody wants to make sure that they get good CAD understanding as soon as they get out of here. So we are well aware of that ability. But I don't think we'll ever let the profession tell us how to run our school, and that's been very strong. In fact, I would say we are the ones guiding the local profession towards opening new possibilities.

We have a wonderful relationship with the local professionals here, but also we have very good relationships with very key professionals in New York City. And they are not necessarily the alumni of the school, but they have interest in our school and the kind of work we do. And so, because of that we have a good sense of where are we going. I would say locally we influence more than they influence us. We are putting out students that have capabilities they don't know how to use yet. So, somehow we have to bring other people, other professionals, up to deal with these skills, and so the curriculum I think has been fundamentally organized by the faculty. And that's been strong, and it's a uniquely experimental school, which we are very proud of. We do not see that we need to be run by anybody else's play book, so we have our own.

Interviewer: You believe that the school is shaping the practice, not the practice is shaping the school?

Omar Khan: I agree to some extent . . . You have some really cutting edge practices that fundamentally have their own little schools, have their own little research groups. And then you have people who are still running, I mean, very respectable practices, but working on a simple old model. And they do simple projects and do good projects. And I think the tendency of these magazines is to concentrate on one end of this, which is very high tech – and with specifically globalized practices that have the money and practices to do that.

In my opinion there is not a single practice out there that I can name you that is doing the kind of work in the Situated Technologies, building design that we are doing . . .

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Omar Khan: . . . This is my concern. Now there are schools that are going out there and buying very rarefied, very expensive technologies, yes, and are capable of sustaining. But I do not have that economy. But I think the ethical question for me here is: how do I make these technologies accessible to as many people as possible? And that means thinking very differently about how we make technologies and how we work with that. So the CNC machines are a good example.

I have students now who are making their own CNC machines. Are they of really high quality? No, but they do not need it; they do not need a micron of precision, you know. We are not milling parts for airplanes; we are doing models. And this is sometimes up to a thousand dollars; that is still expensive. It's about pervasive technologies, ambiguous technologies. How do you make them situated across the economic spectrum? That is the ethics of these technologies because if they are accessible to make people use it, you know, you get more creative. So that is why I feel the technologies are empowered. It is only when they begin to become ways of me to have new – that moves into the fact that I have more money than you to do. But if I have better ideas, money, it doesn't matter.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Omar Khan: There is this question of the advanced technologies, and access to them is one of the biggest problems because we are faced constantly with the fact that there is always something new and it is very expensive. Once we used to have a laptop; you have to pay $2000 for it, but now you get one for $500. We for a very long time had to buy desktops, and we still do to provide for our students.

So, it's a very different economic model than the private school where everybody has the money to buy their own equipment. We can't have that; our students do not come out of those economic backgrounds. We have poverty in America; it's true. And if it's not an American student, we have an international student coming who couldn't afford going to Harvard or other places, came to state school and is tied to the fact that their currency is not equivalent with the dollar and therefore every day is a hard day. So, my interest in technology here is access . . . One is capabilities and instrumentalities. My idea there is if I get ahold of any technology, I am going to try to make it accessible to as many as possible, which means I will find people to teach, people to use that. I'll find programs around which people can learn to work with them. I'll have students work with these things directly, and on the other hand, it's the ideas around which these technologies open up possibilities; that is the purview as a faculty.

. . . It is through those studios that these kinds of decisions get made, where many of these kinds of critical questions come up . . . There is a very, very strong need to make sure that we do not create a new siloes, new complicated ways to access these technologies.

Interviewer: In your graduate research groups, do you accept students from different disciplines?

Omar Khan: Yes, we do. We have a three-and-a-half year program, which is a smaller program than our two-year program, which comes from any profession, and they generally are up to 18 students. They come out of that program everywhere, and those are from wide professional and disciplinary backgrounds. Some are writers; some are artists. Some are scientists, engineers, and they kind of mix together. So, there is different expertise there.

Interviewer: I'm thinking about the idea of collaborative work—

Omar Khan: Yeah, collaborative work is interesting with us. We also have a department of planning; we do join studios with planning, which allows us to think on many scales. So, scale is a very interesting problem for Buffalo because we've got architecture and planning and we can think across from rooms to objects to regions. So we do have that possibility. I think the direct relationship between mechanical engineering – these are things happening more in research here. And so we see that it's much harder to do this, so we don't have joint, for instance, programs with engineering yet. But we have joint programs with media study, which deals more with computing environments in terms of the media. We have with MBA the joint degree program which allows people to take management. We have a planning – so there are joints, which would allow naturally for different people to collaborate.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Omar Khan: No, I think I have sort of covered most everything. It was pretty extensive. If something else comes up, I will bring it up. I think I'll reiterate, for me, situating technologies is the hardest part that we have to deal with now, and that is ethical and economic dimensions, but really creative dimension. It's really another way of thinking about computing that I do not think many schools are doing. It is not just how to make new tools, but how you now think about the environment. That's competitions embedded; it's just like the air. There are sensors everywhere, and how do you start thinking about design along that? So my hope is that when these technologies become more cheaper and pervasive, you will see more interest in trying to address that.

Interviewer: Well, thank you for your time. It's really a pleasure.

Omar Khan: You are very welcome. Let me see what comes out of it; it will be great to follow-up on it.

Interviewer: Will do.

14) Phillip Anzalone

Interviewer: **Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at Columbia University, Graduate School of Architecture, Planning and Preservation?**

Phillip Anzalone: Yes, they do. Columbia, the Graduate School, when I was a student years ago, started doing the digital design studios. At that time it wasn't fabrication; it was just computational design, 3D modeling, and so on. Under Bernard Tschumi, there was a huge change. We had the first paperless studio in 1996, I believe it was, where there was no drawing. So it was all in the computer. At that time it was – oh, sorry, '96 – at that time it was cutting-edge technology, right? And so, digital technology continues to be an aspect of the schools pedagogy. Now just for logistical information, all the students that come have a computer at their desk. We have all kinds of software; we don't advocate a specific type. So they have Rhino, AutoCAD, CATIA, all of the stuff, licenses done already, and they work at their desk. They usually have a computer as well of their own, so they sometimes have two machines running. But the importance for us is the complete immersion into the digital technology world. And, by that method it becomes a tool for them to work with. And so in a way it falls to the background too at the same time. I mean, everybody uses a computer, so it's important to the education.

Interviewer: Was the paperless studio a phase and then the school dropped it?

Phillip Anzalone: No, it continued. So it was the year before I was a student here. I was in the second year of the paperless design studio. I did take one of the paperless studios too. And then they slowly became more and more, you know. First, it was just one or two studios, and then more and more. And eventually they used paper, and they printed and so on.

But, to present, it was always done on computers, and now we almost always present all of the work as presentations as that sort of PowerPoint-ish presentation or whatever. Videos, things like that, something digital. And then now one of the recent things – and I know that we were going to get into this later on – is some of the actual fabrication work. And that's where I come in, and that's why I was brought in eight years ago, to introduce to the curriculum as well. So – but it's everywhere. It's just a normal operation. And some people actually take a critical point of view and turn around and say, "I'm going to do some paper hand drawings," and things like that, but it's unusual. It would be a critical response and not necessarily a logistical response of saying, "You know, I'm better at it with my hand," or something.

Interviewer: So why the paperless studio?

Phillip Anzalone: Well, you know, a lot of our allied fields that deal with industrial design and aeronautic design and things like that were using computers for the analysis portion of the work, as well as some of the design portion. And it's kind of the evolution of the drawing to something like computers. If we look at it at the time, the firms that were out there using and advocating the use of computation tools as part of the design – well, okay, as part of the practice – would argue for their increased efficiency. So, in other words, you don't have to redraw on Mylar. When I started undergrad I drew by hand on Mylar with ink, and I'd have to erase and re— so this is really inefficient if you think about it because you can get more done with the computer even at that time when the computers were much slower than they are now. The thing that changed, I think with education approaching this – and Columbia was one of the first schools but it wasn't the only school, of course – is that the computation became a design tool. So instead, it used to be that you would have the principal of the firm sketch up the drawing and give it to somebody to draw on the computer. That wasn't that long ago. I mean, I did that when I was a recent graduate.

So now the design is done in the computer. And it's funny because sometimes the practitioners, the partners of the firm, feel that they must know how to use the computer. You know, it's turned around, and the younger people graduating with these skills actually command a little more power than they used to. You know, at the time when they were just drafters, and you just hand them the paper and draw, that kind of thing – so that's what the school teaches, to critically think about how the tools changed the way you design. In other words, there is some efficiency aspect to it, but there's also the ability to do things that you couldn't really draw in reality very easily, let's say. There's also the ability to do analysis that allows you to say, "Well, this is a more efficient building because of this." Or, "I'm using less material because of this." Incorporating it with other things like digital fabrication, like computational analysis, to help design efficient buildings like solar analysis and things like that – so the tools themselves are able to help change how you do design instead of just being a faster pencil.

Interviewer: Who introduced the paperless studio?

Phillip Anzalone: Who introduced it? Well, the dean at the time was Bernard Tschumi. It was his brainchild, let's say. He was a professor in the paperless studio back in '97. And I eventually went to work for him for a few years after that . . .

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school? Is there a specific technological paradigm that you're using?

Phillip Anzalone: No, and I think the important thing about Columbia – and what I learned when I came to school here, and it's still part of it – is that there's a huge amount of diversity. It's even more so now under Mark Wigley than it was under Bernard at that time. But the diversity is about the ability for – if you have an interest in a certain area, there's somebody here that does that. And so there's no overriding philosophy of the school. That happens in the design and conceptual sense, the fact that we have people like

Mary McLeod and Ken Frampton teaching alongside Mark Wigley and some of the younger faculty that teach much more advanced or, let's say, more contemporary conceptual ideas in that area. And then we have the same sort of thing with the technology where we don't necessarily, for instance, teach a certain software. Let the students just figure it out. The students like self-taught, self-motivated workshops where they teach each other and things like that. But we don't have a class in AutoCAD or Rhino or things like that.

Interviewer: Do you organize that workshop?

Phillip Anzalone: . . . I think what happens is a lot of students out of Columbia tend to go into education, especially in the area. If you look at Pratt Institute, like half the faculty are Columbia graduates or more. So a lot of the students, they're self-motivated to teach. And so basically I think even sometimes a third-year person will volunteer to spend two hours over the weekend to teach Rhino to a bunch of people just because they're learning how to teach. It's part of their education, you know? So I think that kind of happens, self-motivating. But there's also a lot of workshops that are set up . . .

Interviewer: But you do require it in the class?

Phillip Anzalone: Oh well, it's not firmly required. But in general almost everybody does. So, you know, it would be really hard to pursue an education here without using a computer. I can't imagine how it would work. But the students have to learn how to use them themselves. We don't teach the skills; we teach the concepts. So that's what makes it a bit different from a lot of schools, especially in the undergraduate school because an undergraduate has to teach skills almost exclusively, whereas once you're in graduate level, you're expected to be able to figure things out yourself. And we even take it further and say, "We're not even going to offer the classes." You have – you have to learn it through doing it, right?

Interviewer: Professor, you said that there's a diversity of technological paradigms that the school is using. How are they integrated into the curriculum?

Phillip Anzalone: Well, I think that here we have four fundamental departments. We have the studio, which is the design group. We have history theory. We have what's called visual studies and then technology. There's a lot of different sort of things which have a more specific role to play, but those are the fundamentals, the curriculum of the classes that are taught. And in studio, the professors are allowed to develop – some of the earlier studios are all the same, but the later ones come heavily laden with a certain types of processes or technological concepts or paradigms, as you put it. And sometimes it doesn't, and so the students are – it's up to them to decide how they present their work or how they go about doing it. So it could come top-down from the professors saying, "We're going to study. . ." You know, as I recall there was a study of, let's say, tall buildings. And I'm bringing in engineers from a certain company that use a certain software that we're going to use to do the development of these tall buildings, and then we’re going to have a certain way of producing. It could be very prescriptive.

On the other end of the spectrum, you have somebody like, let’s say, Steven Hall, where it’s design, you know, it’s architecture in what I would call sort of the old school method. But all the students are using computers, and they come up with their own method of developing or not developing their own conceptual operational method. And so that would just be, maybe, be a bottom-up approach where the students develop all of that. Now, history theory doesn’t really engage it quite as much, and technology uses the computer more as a tool. The tech group [is], you know, buildings and science and technology, basically. These are the structure classes, [HVAC], these kinds of things. And typically the computer is used more as a method of doing analysis and design at a very technical level, the drawing, the BIM modeling and things like that, as well as the analysis software.

In individual study group, that’s where you have a wide mixture. It used to be the computer group, but it’s not anymore. It’s about something much broader than, let’s say, just using the computer. They teach different software, but they also teach, let’s say, digital photography and things like that. So that’s where we get a lot of mixture. It’s all of the young faculty there, typically. And they teach short, six-week classes, so they’re able to be very fluid and change what things are and so on. So that’s just a big pot where things are getting mixed up.

Interviewer: But no one enforces them or asks them to teach that way or the other?

Phillip Anzalone: . . . A person who wants to teach, they have something they want to do and they present to whoever it is that decides. So somebody will present to me as the building science and technology director, “I want to teach this class. Here’s what I think.” Sometimes it even goes to Mark if it’s a studio or whatever. So there is some level of control, a bit, but typically nobody says, “Well, this is a great idea, except if you were using AutoCAD it’d be better.” I mean, that doesn’t happen. So, basically people are allowed to develop their own methodology.

Interviewer: All the four groups are graduate?

Phillip Anzalone: Oh, graduate. We don’t have an undergraduate curriculum here. It’s so funny because there’s the university and then there’s Columbia College, which is across the street. And so at the university, we don’t have an undergraduate.

Interviewer: How long have these [digital] models/paradigms informed your curriculum? Who introduced these models to your curriculum? A professor, administrator, or a student?

Phillip Anzalone: I think it’s kind of evolved. Likely early on it came from the professor’s interest, but also it’s a combination of a professor’s interest and students’ capability. So what happens is that a professor will talk about something, but maybe not necessarily know how to do it on the computer. Because, like anybody who runs a firm, they don't do all of the stuff. And the students will experiment, and between the two of them, they come up with something new, and the next time, the next year, it steps up. And so it would just continue to evolve into something that goes a certain direction. It could start out very fundamental and not really work, but then later on it becomes an operational methodology. So I think it's an evolving sort of thing. I mean, there are champions to these things. Bernard was a champion for the digital paperless studio. I was the one who was brought in to set up the whole digital fabrication, the lab, and everything here. So the people drive these things, but in general, it's an evolutionary process.

Interviewer: What do you think are the positive and negative implications of these paradigms?

Phillip Anzalone: Well, that's a good question. I like that question because I think that a lot of times people disregard the negative to it. You know, I hang out, see, talk to a lot of people that are in digital. I would be specific about digital fabrication because it's my area. The construction of things using digital tools, as well as design – I mean, that's obviously tied to it – but I'm more on the making end than the design end. But a lot of people I hang out with imagine that we're just going to 3D print our buildings. I think that there are limits to what this technology can do. Even in the future, I think there'll be limits.

There's always limits. You know, imagine, oh yeah, but 10 years from now, we'll be able to do it. But there's going to be new problems 10 years from now, or other ways of doing it 10 years from now. So we have to look at what we're doing and imagine how we can increase what we're doing, but also deal with the limitations and the negative parts of it. The positive is, of course, the computer is much faster than us at a lot of things, computation and so on. It's much more efficient. It's becoming ubiquitous, and you have this ability for things to be well networked together and to coordinate with each other. And I think the negatives derive from the same sort of problem.

I mean, as an example, a very specific example, a lot of the tech courses I teach, if you do an analysis of a problem, if you don't understand the fundamentals of what the problem is, the analysis isn't going to work. It's garbage in, garbage out theory, right? If, like, let's say we're doing analysis of the wall and how the sun is coming in, and the computer can do the billion calculations and tell you what's the most efficient. But if you don't understand even what it's giving you, much less how you set up the problem, then how are you guaranteeing you're getting the right answer to the problem? So the thing is when I teach the students in the tech courses, in the science and technology courses, I teach them how to do it the old school calculation method. Like, how you would calculate thermal properties across the building wall. Then I show them the computer program that will do it like a million times faster. But at least they understand how it was done the first time through.

So I think one of the biggest problems is that sometimes people don't actually know the problem that they're assigning the computer to do. They're just thinking, 'Because the computer told me, it's right.' And it's not a guarantee. Anybody like NASA or anything like that will have a degree of error involved in some of their calculations. We don't even do that; we just assume that the computer was right, so that's kind of problematic.

Interviewer: What kind of software simulation are you using?

Phillip Anzalone: Well, on the design side, the students use things like AutoCAD, Rhino, a lot of the typical stuff that we've heard of. In the analysis portion, one of the software that I think is useful with the educational level is SolidWorks because it's made by CATIA. They're the same company, but it's a much simpler version of it so it's easier to learn. You can do analysis of those components and assemblies and things like that, and it's relatively quick to learn and it's cheap. That means it's not that expensive so the students can actually buy the software; it's not $10,000 or something ridiculous like that. We also have a lot of things like Ecotech, which is now owned by AutoCAD, I think. The monopoly effect is coming in where AutoCAD owns everything and then there's a few different people. But Ecotech is one example. And then there's a lot of plug-ins for Rhino and so on that are used for different types of analysis and so on. And then we have our engineer – our class is taught by engineers in our science and technology program. A lot of the software like SAP and things like that that are used in engineering schools and firms.

Interviewer: Do you believe, Professor, using software by itself for simulation, like to study an environmental conditions, is not enough?

Phillip Anzalone: I think they have to know what they're [simulating]. It's hard to explain, but it's just a fundamental way, I feel, is that if you don't know the foundation of what is happening, it's really hard to imagine because you are setting up the computer to answer a problem. And if you don't set it up correctly, how can the computer do it by itself? Unless it's a just simple problem that's been done a million times, but the problems we have as architects are not like that. They're very complex, and they have a lot of other parameters that we leave out. When we do a solar analysis, we never consider clouds in the way of the sun, right? So it's part of the real world, and if you really wanted to do an analysis, you would have to consider London is not going to be optimal for solar no matter what.

So, there's ways to look at the problem in a very simple abstract way that the computer deals with, but also we have to keep our mind in reality of how things really work. Something can tell you this is cheaper because there's less material, but then somebody who builds these buildings all day long can come and say, "Yeah, but it's going to be super expensive to put together." And so it's not cheaper just because you have less material. So you have to understand the bigger picture too, I think.

Interviewer: How do you believe technological models have shaped the critical thinking of architecture pedagogy historically?

Phillip Anzalone: Well, we haven't been around that long with digital. I think there's been an increase in the idea of doing iterative design so you can do something quickly and do lots of examples. I remember when I was an undergrad drawing by hand, you could change your design once or twice in a semester, but that's about it. Otherwise you are not going to get very far, whereas now you can do a thousand the first week because the computer cranks out a whole bunch of them. So this concept of the iterative design, I think we can have more complexity, be it geometric or material-based or something like that in the design, so it's allowed a degree of speed and complexity and all of these kinds of futuristic sounding methodologies that we never had before. And it's changed. You look at some of the contemporary architecture – some of it still could have been done 30 years ago, but a lot of that is something that couldn't have been, and a lot of it has to do with how the computer operates.

So it has had a huge impact on the practice as well as pedagogy, you know, and the way we visualize things. You know, we show presentations and shiny objects all curvy, and that's just the normal thing now in architecture school, whereas 20 years ago people would have been like, 'What are you designing, a slide or a building?'

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? And how so?

Phillip Anzalone: . . . In the '90s we went to full-on digital and there was a time when nobody had anything drawn or rendered or anything on their desk here at Columbia, let's say – it was all on the computer, and you could only talk by playing with the mouse. And oftentimes the designs were not buildable; let's say they were a bit more utopian and futuristic, right? I think it's turned around, and people have said, "Okay, we've done all of the crazy geometry we possibly can, all of the impossible to build buildings, all of things that aren't even buildings or we're calling buildings as architects. Now let's see how we can actually build them." Sometimes this follows the economic cycles, too. Oh, the heyday of doing the crazy stuff was also when there was plenty of money. And now that there's less money, less being built; you can't design something insane because nobody's going to build it.

. . . I think that an important new aspect that schools are starting to get into is saying, "Okay, let's experiment with building." And it's not about the Habitat for Humanity, which is a good program, but as an example they build in known technologies where you know the outcome. They're going to build the house, and they have to have a house that is nice for people to live in. The schools are building stuff that may or may not fail, right? They don't want them to fail, but they could. And the failure is something you learn from, too, as well because it's an experiment. So, this experimental making, I think, is the same as the experimental digital design we used to do, and now I think that that's coming online.

And then, I think something that's looking into the future is the connection between the industry and academia, which is starting to play out. There's good and bad of that. We don't want to be too close to real world in academia, but I think that there's something to be learned from experience and how things really work, right? And then industry wants to see from us what is the future, so it's a symbiotic relationship we could cultivate.

Interviewer: Yeah, there's an argument about if practice is shaping academia or academia shaping practice?

Phillip Anzalone: Yeah, I think it goes both ways.

Interviewer: It used to be academia shaped practice back with the Bauhaus—

Phillip Anzalone: . . . In the area of the construction and so on are starting to recognize that there is something to be learned from people in academia . . . Look at something like Apple as an example. I mean, if they weren't futuristically thinking, we wouldn't have iPhones and so forth. And I think that some of the people in construction that are smart are saying, "Let's not be stagnant and do things we used to always do. Let's look ahead. Where can we find people doing this?" Well it's the architects we deal with – but even better that the schools that they come out of 'cause they're doing stuff that['s] crazy and nine out of ten won't work, but one of them could. And that could be our construction version of the iPhone, and so [it could] change the way we do things. They're starting to be interested in this kind of collaborative work . . .

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

Phillip Anzalone: . . . My gut instinct is to say some sort of method of using the tools to network together how we operate . . . There's the logistics of the BIM model where we're all working on the same model, but there's also, I think, an understanding that architects kinda have to understand how it's done at the production side and engineers and so on.

So there's this network method of operation that I think is very important. And I think that there's pitfalls to that in a way that it becomes possible that one type of operation takes over. And we see that sometimes in some firms where you can instantly pick out the building, and it's because the design the construction company used – they're all the same. And they're refining that method, right? And it's becoming very fast and very perfect. But it's spitting out one building. It's like a machine that shoots out the same building. And there are a few big firms that do that, and you can look at every city at one of the museums made by a certain architect. You can just pick out the building 'cause they all look the same.

Interviewer: A cookie cutter.

Phillip Anzalone: Exactly, it becomes like that. And I think that that comes from this process of efficiency, and it becomes the path of least resistance. And then if we step back and look at it, we say, 'oh my God.' You know, if I wanted 15 years ago to design a building, I would get out graphic standards and draw exactly what graphic standards have. That would be the path of least resistance; you could build a building that's totally functional. Who cares what it looks like? And that's the same method. But people are excited because it's digital, but why should that be any different than any other way of producing things? So I think that we have to be careful that we're critical, that we're always looking at what we're doing and how can we do things. How can we improve or change? . . .

Interviewer: So we may see more collaborative work in the future.

Phillip Anzalone: Right, sort of a collaborative working, but a critical analysis. I think that that's important. I think that's really important. You have to constantly question in the realm of digital design and in fabrication because it's too easy to produce things. And if you don't question them, you take what the machines give you, and if you do that, you're just doing what's been done before in a way. You're not really innovating.

Interviewer: On the influence of technology/technological paradigms on the social formation and culture of architecture schools, how are digital technologies and their associated paradigms shaping the social structures and culture of the architecture design studio of your school? . . . **Like, you talked about the paperless studios – that was a huge change, the way that the professor interacted with the students' projects and the students themselves.**

Phillip Anzalone: That's true. Okay, so there's sometimes a funny reversal of the professor-student relationship because the professor is interested in something and the students are the ones that are actually able to do it. I think that that's one thing that's true. I guess there's more – I don't know if it's collaborative – but more of a relationship between people because what happens is that somebody will figure out some way of doing something and then somebody else will say, "How'd you that?" And so that person gets to explain it, and then it works in different ways with others – so there's an interaction in the studio, or even in the other studios . . . People come sometimes here and say, "Who should I take for my studio professor?" They actually ask me that quite a lot. And, in a way, I think it's a loaded question because I could tell you, based on your work, you may want to do something different or the same or refine, whatever, but everybody learns more from their peers than they do from their professors.

I mean, they see the professors like one hour, two hours a week. But you're working with your peers constantly, and those are the people that you'll eventually work with in practice too. You're not going to be working with your professors in practice. So the group, the peer group, is really how they start to work together. And so, sometimes it's competitive, and sometimes people don't work well together. But typically, in a situation where everybody feels that they are hitting in the same direction, I think that that's good. And what's interesting is that has do with each other, but the integrated product development, IPD methodology, of saying ‘We’re all on the same team. We’re all going to share the risk, and we all want this building to look great at the end of the day. Let’s figure out how to do that’ is the same way that the studios are operating. So it’s not the old method from 50 years ago where you’d hide your drawing from everybody and you don’t tell anybody how you did that. Now they are much more open to interaction, which I think is interesting.

Interviewer: Do you create blogs to communicate with your students, post tutorials?

Phillip Anzalone: . . . We do tutorials. Yeah, I do tutorials, but it’s a one way [communication].

Interviewer: Online as well.

Phillip Anzalone: Yeah, they’re online. Well, yeah, but I’m not so sure about what can be accessed from the outside or not. But, at least from the school they’re online in such a way that we would tell students how to do certain things in the software, how to use certain machines or whatever. So it becomes this kind of lecture: here is the information, you use it. But on the other end, the social networking kind of blogs and things like that, there’s some studios that do use that . . . [It] takes a long time to develop a blog methodology, and I’ve never really been involved with that. My work is usually more hands-on, and so we have to be in person. But I have seen the blog sort of thing work, and it’s an interesting method of discussing back and forth. And it’s the way that you can talk with somebody about how to do something without actually having to be there to do it.

But, this school has a particular [community], and it has to do a little bit with its location. The Columbia University has housing all around, and typically students that come from abroad. It’s much more expensive to live in the city, let’s say, downtown. So they have the cheaper apartments that Columbia organizes and owns and rents out. So the point of that is that let’s say 90 to 95 percent of the students live in a five-block radius of the university, and there’s nothing up here to do because it’s not downtown. So basically the students are in the studio quite often. We have the computers there with all of the software they could ever want. The goal is that the students are there together collaborating and working together. So that’s part of the bigger picture. That’s something Mark Wrigley would talk about, right, if you were having interviews, that he wants the students all together sitting practically on top of each other ’cause that’s how you learn things and so on.

And so that’s a huge part of how the school operates, which is different from other schools I know where people will come into the studio and then leave. It’s a commuter school. There’s even those in New York, so it’s a different mentality. And I think that’s critical, and it’s also helpful for people ’cause they can see what somebody’s doing ’cause you’re literally that close . . .

Interviewer: Well, I assume in the paperless studios, you still do physical models.

Phillip Anzalone: They didn't, no. They wouldn't, not at the time. But now we do. My lab is the one-to-one full-scale fabrication lab, but we also have an output shop where they have the laser cutters and the 3D printers. And so this is where the digital becomes a model. I do more building systems and full-scale, prototyping. But before all of that equipment was here, there were no ways to actually model the things that you were doing. [There] was a time, let's say in the late '90s or early 2000s, where in order to have a discussion about your project, even printing it wouldn't do it; you have to go the computer with the mouse and rotate it around. It's the only way, so people would do animations, and then they would show the animation because it's the only way to really represent it.

But now we have the technology in the digital prototyping like the 3D printing or laser cutting, to actually build some of the funny things that would be designed so that you could hold it in your hand. And then you could have a discussion in person instead of staring at a screen. So I think that that's been a huge part about that; people think they design something, and then they'll wait till the last minute. It's do now, print later, right? And then you look at it, and you're just like, "It's not really what I wanted." But it's the end of the years, so there we go. It's a done – I mean, it's expensive to do. It takes some time, and so some of the stuff never really gets the iterations it really should.

Interviewer: I know that Richard Meier did a long distance studio.

Phillip Anzalone: . . . Yeah some of our professors are very busy with their practice. They'll be ready to teach studio, and sometimes they get a huge project that they have to be – sometimes practice has to take over, but they manage ways of dealing with some of the remote aspects of that . . .

Interviewer: Yeah, but then how will you test materials and fabrication techniques?

Phillip Anzalone: Yeah, but that's where my lab that comes into play because I really focus on the material, the assembly of things, how things are fabricated.

Interviewer: It's a fabrication class.

Phillip Anzalone: . . . It's a lab, and we do research, yes . . . This includes the wood shop and the metal shop and things like that, but it's open to students to use as a facility for them to do their models or whatever work or whatever. But the funded research is done with the same equipment or with other equipment – sometimes outside of the university or in other areas depending on what the research is – but through my lab. So, you know, we'll be researching a certain structural system type and doing prototypes of it and so on. We use our machines, but we also use other stuff as well . . . But it takes a big learning curve. Like the CNC equipment, it isn't something you pick up right away. It takes a semester to figure it out and two more semesters to get good at it enough to do your own design work.

Interviewer: To be critical.

Phillip Anzalone: Exactly. Somebody starts relatively early in their career – like halfway through the three years here – by the time they get out, they're pretty good at it, and they can go on to work at firms. Some people never touch the equipment, never go in the lab, but they're exposed to it. They see what it can do, and maybe that's enough for them. So there's a variety of ways. Sometimes people get too much into the machine and how you build and stuff like that, you know, and I think that's great. And I like to do it myself, too, but having a practice – that's not what I do in real life. And I wonder sometimes about people that get too much into it, how hard it's going to be to find a job that's going to feel fulfilling to you because nobody does that. Architects don't really build buildings. The contractors do.

Interviewer: What social models or organizations – for example team-based design, hierarchal organization, agile organization, or even individual models – are enabled or disabled by the integration of these technologies?

Phillip Anzalone: I think that it can work either way on all of them. The technology allows a small firm to look like a large firm if they have to. It allows people to work remotely. But then I think that without constraints things tend to have a lot more opportunity for failure . . . A firm that opens up where there's five partners and they all live in different areas may be interesting technologically, and you may be able to force it to work, but it's always going to have problems with it that are associated with the fact that lots of different things happen. And so, without the constraint of saying certain things, we have a historic method of building. Making architecture, like, through the design to the making part. Let's work within that method because you know, one group may say, "Well we're going to live all over the world." But their contractors don't live all over the world, and their engineers don't live all over the world.

So sometimes you have to deal with the constraints of reality, which is – that's your practice, but then there's also material reality and cost realities and other things like that. So I think that it's important that [just because] the abilities of the computer . . . allow you to do things doesn't mean that's the way it should be. That's a possibility, but also to look at traditional methods of operation because that's where the bulk of how you deal with these kind of collaborative methods are going to be. It's all of the people that you work with. They all have their own life, you know. They're not all computer junkies, so basically you have to take that into account. Although everybody has email, right?

Interviewer: How about in the design studio? Because of technology students are working more in teams.

Phillip Anzalone: It's a bit easier to work in teams. It's true that there's a lot more teamwork. I think the team thing comes from the fact that you can produce more stuff.

Quite honestly, I think it's a very fundamental sort of selfish reason, that you can make more things by having four people make it rather than one.

But I know that some students sometimes get team burn-out. We have six semesters here, and the first three semesters are heavy team projects, and the first three studios as well as – not only teams, but you're doing the same projects. So, like, the first semester, students are all doing the same project. They do it differently, but they all do the same stuff. So you get sick of seeing the same thing and the same people. By the fourth semester, they really just want – they're burnt out on team projects, and they want to do their own thing. And we encourage that, so the last three semesters are individual projects, individual research, we call it, and they develop their own method of operation. So I think it's important that we have both of them.

Interviewer: Do these technologies positively or negatively affect their interaction and learning within the design studio?

Phillip Anzalone: I guess it can work both ways. But generally it's positive. There's probably some problems that some faculty may have with certain technologies that cause things to be a certain way or something like that. But, in general, I think that, here at least, the technology has become just a background tool. There used to be a time when the focus was on what tool you were using or what software you were using. I think that time has passed, and so now it becomes less – students don't say, "Oh, I used Rhino to do this." They shouldn't, at least, because they don't care if you used Rhino to do it. What is it that you're doing? So I think that the fascination with the computer software and so on has slowly gone away to the point that we can talk more again about what you're producing, the architecture and so on, which I think is more important. So I think it's become a little bit easier for the faculty because the faculty doesn't want to teach Rhino; they're teaching architecture. So, let's talk about architecture instead of Rhino and how hard it is to do this, or what you can and can't do with it.

Interviewer: And also, you mentioned that it's a positive for students to share their knowledge.

Phillip Anzalone: Yeah. Super positive.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Phillip Anzalone: Well, I think that's a big question. I think it's a hard one to answer now because, I think, the reason why is it's coming from the outside of architecture. And I'll point to specifically MIT as an example of their open source education project. The concept of the, especially expensive, education is being called into question, right? In theory people say, "Why should I pay to go to MIT when I can get all their content online?" I think that that – the cost of things, the economics of the world right now, and so on, the fact that people are all over the world or can be interacting – all of these things are bringing into question the old notion of the studio space. That is one place where everybody comes to hear the professor, you know, like Socrates, talk, right?

Now I think that that's coming into question. But I hold the other point of view. I think you do have to have that in some way. I mean, there's no way I could teach what I do to somebody 5000 miles away. It's impossible because we build stuff. So, in my personal office, I've had freelancers where they would work at their home, and it doesn't work out so well either. You have to be able to talk about something in front of you. So I think that it's a big question now. I'm sure that paying for MIT and going in and talking to the professors and sitting through the lectures is much more valuable than just watching them online. But at the same time people are saying, "I can't afford it, and what if I just watch them online? I get the same information." So, I don't know. I think we're at that challenging point, but I think a lot of that question has to do with the fundamental definition of what a university is. And I think that that's starting to be questioned and how it changes is going to affect a lot of the studio environment.

Interviewer: On teaching students to critically engage the use of technology in the design studio, do you teach students to critically engage and question technology/technological paradigms within the design studio? How?

Phillip Anzalone: . . . I do it through the construction process, success and failure of building things. A lot of times my focus – when we do design projects or any of the workshops or whatever – is there's a certain thing you want to get. Usually it's not questioning the design so much because if I say, "Okay, you've developed a design. That's what you wanted to do. Now how do you make it? And how does that go back and affect the design?" – because once you figure out how to make it, it could look like crap because there's just no way to make it look that nice. So you have to go back to your design and say, "Actually, if I'd designed it this way instead, with a different style, with a different methodology, with a different material, I could produce something that actually looks nice," right? So there's play back and forth between what happens when you make something and how the designer looks at the area that I operate. So that, I feel, is the critical feedback loop of the designs. So, I don't engage the design as much except in the feedback from that built product.

Interviewer: In some juries I've seen students present their Grasshopper definition, for example, just to show us how they come up with the form. I don't see much of critical thinking there; it's just like a slider or something that they moved intentionally or unintentionally to create that interesting or complex form. So, there is no reasoning.

Phillip Anzalone: . . . If you made it, I would ask you, "Okay, what are the assumptions involved in this mechanism of making it?" I think that that's a valid area of potential design, but I think that that requires that the person doing it be able to clearly define the reason why they put it together a certain way. So, in other words, you have something that changes the size of a piece of something, right? Why? Why does it do that? Because

I can take a piece of paper and change the size of it, right? But what am I doing in reality? Is the size changing because you're using a different type of material? I'll be very physical about it, let's say. Is the size changing because you don't have so much money? . . .

A lot of people do calculations with formulas but have no idea what the formulas are doing, right? You're saying that changing this makes it much more structurally efficient. Show me your formula, and let's see if it matches the formula that Newton invented 300 years ago because you may be just arbitrarily coming up with some shape and saying it's more efficient, right? I think if you dig into it, there's a possibility of looking at it. And then if you think about doing all that digging then you step back and say, "Well, you're just doing something that a machine or robot can do." It's not a human being saying, "Yeah, I know that's more efficient, but it's not nice looking." No machine's going to tell you whether it's nice looking or not. So, I don't know. There's a lot of potential, but I haven't engaged it as much myself because in the review, as you say, you see the definition as some sort of background drawing. And nobody knows what it means, and you don't have time to talk about it and things like that.

Interviewer: Well, I'd like to see more of a reasoning diagram.

Phillip Anzalone: Yeah, I agree, like a flowchart. And I think that that's true. And maybe it's there, but we don't know. And so it's hidden behind this like Grasshopper spaghetti.

Interviewer: How about if we taught students biology for architecture – like in a biomimicry class – taught them geometry for architecture, math for architecture? Do you think that would make them think critically that, because we don't offer these classes in schools, we don't give them like biology specifically for architecture? The idea of form, form creation, and nature—

Phillip Anzalone: Yeah. Well, that's what I do. I teach Architecture Technology 1, which is the tech class for students that probably don't have a degree, typically don't have a degree, undergraduate degree, and so they have to get caught up to speed. And I teach structural mechanics and the strength of materials, solar geometry, and Ferro dynamics, and I do the sciences basically at that level. And then I show them that here's structural dynamics . . . And here is a building that's a cantilever, and that's why it's only that short because obviously you can get a lot of deflection at the end . . .

If the students don't understand the fundamental formulas, they don't really know what they're doing. And then, of course, they can get a computer program and show the cantilever and design it like that or whatever. But I think it's key that they do – I think you're right, and it would be nice. In fact, it would be an interesting summer curriculum, right? Before you go to graduate school where look, you learn all of the – it could be sciences – but there's also probably the social sciences and other things that you could learn for architects that would prep you for that sort of thing.

I think [there] could be some portions where it's detrimental. I guess I have a personal nervousness about students that are overly fixated on one certain way because it's not the way the real world works, right? So, if somebody became obsessed about Grasshopper and that's the only way to design, then I would be nervous about that because [they] tend to be more involved with the process and less involved with the product of what you're doing in a way.

So I think your idea of saying there's a whole wide range and you learn all of this stuff and then you can take from it – I'm reluctant to say there should be a middle where you build. I think that's up to the individual to say, "I know all of the stuff now, and this is my palette," rather than saying, "Okay, now here is how you put all that stuff together." I think the students should develop that, but I think we need help in a way. So there is a guiding of them that we as academics do to sort of say, "Okay, you know how to do all the stuff, and how would you put it together for your own way?"

So the student has to be able to articulate what they want. That's a key. At Columbia the students are very good at articulating and saying what they want to do, their ideas. But I've been to lot of schools in reviews . . . [and] some schools don't have such an articulate group of students that are able to say, "I want this. I just want to know how to get there."

So oftentimes they resort to just saying, "I figured out how to do this, and that's my design." . . . But actually, there's a better way to do it. And that's what we as educators have to do is say, "Where do you want to get to?" Not, "How do you do it?" But, "Where do you want to get to?" And then we help them understand 'cause we may not even know how to get to that point.

Interviewer: So you see that, Professor, with Columbia students, you see them think critically when engaging technology in their design?

Phillip Anzalone: I think so, not all of them, not all of them. But I think that some of the better students are able to articulately say what they want to do, look at how it would happen, and then evaluate it. And I think the evaluation is important, yeah.

15) Ronnie Parsons

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school, Pratt Institute?

Ronnie Parsons: At the Pratt Institute, yes, I would say that it's very much an important keystone to the way in which the pedagogy of the school is implemented. So now things are changing a little bit because we have a new chair, you know, so Dagmar Richter is the chair of the school now. Previously it was Evan Douglas. When Evan was at Pratt, he brought us on board. There was definitely a very big influence on the way in which technology could be used to re-think certain types of ways of working and vice versa. How could certain ways of working influence technology in a way, our understanding of technology? . . .

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school?

Ronnie Parsons: You are definitely thinking through associative design methodology. That is very much a part of the design pedagogy at the school. I would say that thinking about technology in terms of means of fabrication since there is now a new CNC, computer numerical control machine, at the school. There is a desire to think about how it can be implemented within the context of the studio, but in a way that may be not in the way that we've seen it used.

Right, so I think there is a desire to go a little bit deeper into the critical kind of understanding of its use and implementation and deployment within the context of the studio's projects besides the uses of it, like surface milling for instance., but actually start to think about ways that it might be used or interrogated more critically.

Interviewer: Is there a significant technological framework that Pratt Institute is working with right now, for example a general systems theory, information theory, network theory?

Ronnie Parsons: Well, there is definitely the presence of a computational paradigm, one that is centered in both the sciences and mathematics, as well as biology. You are starting to see now a shift, most of it because of mandates according to accreditation, that introduction of information management systems, (BIM) building information management systems or something introduced as well. So I would say Pratt's may be a unique case because of the fact that it has such a long history of dealing with experimentation in architecture.

The faculty [are] proficient or expert, or whatever you may call it, in the use of technology and experimentation for design. They kind of affect everything across the board . . . For instance, in the course that Gil Akos and I teach there was desire to rethink the way that representation could be taught through the lens of changing means of representation and production, so specifically associated based processes, so parametric design and grid based modeling paradigms. Then [we] also [introduce] the use of the laser, specifically the laser for this class, to start to see how materials specific effects might begin to practice. There is always a focus at Pratt Institute to deal with material and to understand the real world implications of what you are doing through a process of making, and because of that the use of technology is viewed critically, right? So does that help you a little?

Interviewer: Of course, it's quite helpful. I remember four years ago I've passed by an architecture jury where they emphasized the idea of a unit in their design project to create a system.

Ronnie Parsons: You start with a unit and then through a series of transformations the unit aggregates, and its aggregation starts to amount [to] some sort of a larger structure or a system, right?

I wouldn't say that necessarily systems theory is something which is the center of the design pedagogy, but rather a critical engagement with various kinds of directions that are coming from ways of thinking about the world through the lines of computation . . .

Interviewer: How are they integrated into the curriculum?

Ronnie Parsons: . . . As early as the first year, they are already starting to introduce them to using the computer in a way to think through abstraction, not just the computers as a way to produce documentation. So abstraction is key, right? Because there is an emphasis on modeling by hands and making, there is also a need to be able to understand the affect that the computer could be used as the translative device as well.

Right, so how can you take something which is physical, made by the hand, made through an algorithmic process, for instance . . . and then take that and translate it digitally? I mean that there is something that happens; it's not a direct correlation to what we had before, but actually through the process and taking it to the computer, you kind of re-contextualize, re-authenticate, re-invigorate what you had before because of the new media. So that happens all the way at the very beginning. There are seminars that are special topic seminars, which are 500-level – you take them in your third year or higher, I believe – and those touch on more specific issues than what you would take in or get from an introduction to modeling course or something like that. But, again, a lot of these things are changing. I know that the curriculum with the new changes are to be implemented starting in the Fall. There will be much more of a presence of the computer laterally across the board, and it will be understood that the computer, the pen, the pencil, model making, everything will just be seen as one continual.

Interviewer: Are all students required to take these special topic classes?

Ronnie Parsons: Yes, there are requirements for 500s. I think you have two from the school of architecture; you have some four which are university wide, but they can also be supplemented within the school of architecture . . . You're going to have a required advanced theory and at least one supplemental computing course because you go through a representation of sequence one, two, and three. By the time you are out of three, you've covered all of the kind of basic representation tools – Photoshop, Illustrator, and InDesign, that sort of stuff, AutoCAD, Rhino, and some sort of parametric tool, rendering, advanced modeling in Rhino – and then those are just the requirements. Then after that you have supplemental courses. So you can do a course with Revit; you can do a course with animation in Maya, scripting, premature design. We do a special topic seminar in digital fabrications, special topic seminar in simulation, and then representation 3. So we cover a lot of the advanced computing topics.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

Ronnie Parson: This has been around a very long time. You have people like Haresh Lalvani, who has been there for 25 years or something. He was coding back in [the] late '70s, so I would say that technology, and specifically how technology influences architectural educations, is not anything new to Pratt at all. Yeah, it's always had a presence there.

Interviewer: You mentioned Evan Douglis' role when he was a chair.

Ronnie Parsons: Yeah, I mean, when Evan was the chair, he definitely pushed things . . . He was very interested in attracting interesting people to the program who had diverse set of ideas, or were willing to experiment. When I say he pushed things, it was not that he pushed the envelope in terms of offering more technology or something like that, but actually getting people in who were experts. Not just experts in maybe a use of technology, but also experts in . . . the critical discourse surround[ing] technology. And so when you get that critical mass together that has that sort of proficiency and experience, it makes for a great conversation. So I would say that . . . he really helped to catalyze a lot of things that were already there by bringing in new voices and really helping to bolster younger faculty and so on.

Interviewer: What do you think are the positive and negative implications of these paradigms?

Ronnie Parsons: . . . It's a funny question in a way because at this point in time you can't escape technology, right? . . . What is negative about it? I mean at this point in time, I would say it's very difficult to be able to kind of discern one being positive or negative. I just see this: it's here. It is there; it's not going anywhere at this point in time . . .

Interviewer: It may help in closing the gap between different disciplines?

Ronnie Parsons: . . . I think that that maybe speaks more to the various disciplines that are engaging with architecture currently. The technology just makes it more apparent. It's nothing new that architects were talking to biologist, or that architects are looking at physical stimulations. I mean Antoni Gaudí was looking at stimulation, so he was a total technophile, right? That was many years ago. So I don't know. I think that what technology allows us is to see that more clearly, but I don't think it's anything new at all.

. . . If you were to ask, say, that question about what are the positive and negative implications of technology within the context of whatever your discipline is and you ask that to somebody like a graphic designer, or you ask that to somebody like a media artist, they will just say, 'what are you talking about?!' I would align myself with that way of thinking about technology because if we say that . . . technology is born out of cultural needs, then identifying what its implications are within the context of discipline is almost like saying, 'well, what's the implication of culture?'

Interviewer: How do you believe technological models shaped architectural pedagogy historically? The use of machine in the Bauhaus and Vhkutemas, for example, had some critical thinking.

Ronnie Parsons: . . . One other thing that technology does afford us today is the reclaiming of kind of lost territories, things that we have given up in the past; we are able to take them back a little bit. So the agency that we have within the context of the built environment is extended by way of technology. Now, whether or not that really changes or radicalizes architectural pedagogy, yes and no, right? But I would say for architecture practice [it] is very much a big yes, alright?

. . . Technology has been a way of being able to index particular cultural forces present. And some people are way out against it, and others align themselves with it. So, I don't know.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years, and if so, how? The role of technology in architecture and design pedagogy—

Ronnie Parsons: . . . Now practice is starting to give examples of how radical things can be, and in a way, architectural education [is] going to catch up. So I think the development of that relationship between technologies and pedagogy in the future is probably going to be something that's going to be way more extreme than what we've seen so far . . . That plateau that existed between, say, an expert or somebody who is highly proficient and somebody who is wanting to use technology – there is always quite a big gap, right, because of the fact that there is so much overhead to get into it . . . There [are] so many ways to learn about these tools that we're taking a big step back and shifting away from talking about necessarily the technique and the tools anymore, now focusing back on other issues which are more designed oriented.

And so, because of that, that big window of freeform experimentation, I think, started to close a little bit, and I think people are starting to get a little bit more keen on the idea of asking why: Why are you doing it, or what are the broader implications of its adoption, etc.? So I think that in the next ten or fifteen years, we're going to see some really radical stuff, and it's not necessarily going to be novelty in form or things that we have had in the past,10 years, 15 years. I think it's going to actually be radically rethinking that kind of deployment of technology within the context of real significant cultural problems . . .

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising? Simulation—

Ronnie Parsons: Simulation is probably one of the biggest things that is on my radar. I think that there will be a lot more developments and emphasis based upon simulation just because of the extreme value of it. Not only as something which has a capacity to validate certain assumptions, but also a gray area, that kind of open-ended area or space where you can really work through properties of material and things like that. I mean, but this is also not very new, you know, if you look up the work of Frei Otto from the '70s, so the work with analog machines using simulation as a means of being able to derive a form finding processes. But, I think that that is maybe one of the most cut and dried examples [of] what simulation can do . . . You can simulate, obviously, the way people move through spaces. You can simulate energy; you can simulate all those really amazing things to be able to extend design space that you have, in order to understand the choices that you are making as a designer.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

Ronnie Parsons: One thing . . . is just the access to information . . . Now, you're seeing more and more that schools are shifting to lighter weight infrastructure tutorials, video-based, tutorial document-based, workshops, putting the teaching on the students and actually having students learn it on their own and share what they know with other students. Collaboration is becoming a lot more central to the design studio., which I think is very interesting not just in terms of the way that students learn and share, but also there is a really strong emphasis on how they can collaborate with disciplines outside of design.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Ronnie Parsons: In the past, I think the thing that caused a big divide, was that there were few people who had the precision and the knowhow to use the tools, right? . . . You had a few people who knew how to do all these things, who did not share what they had to do because they were the ones who knew how to do it. All right, so there was much, much more of a desire to have solo authorship then there was the emergence of the competition of laws. It's totally pervasive at this point . . .

So now there is no real need or even validity in claiming authorship over anything. In the studio context that desire to hold back information doesn't exist because the attitude or the way that the students actually understand and associate themselves with technology is everywhere, so saying what's positive or negative it's just kind of – I don't know how you would make the claim either way because it's precisely that. Whenever you have a group of individuals who have always known technology and have always understood technology – not just that it exists but actually that it's cloud-based, multiple entity, multiple people collaborating in multiple spaces all the time, be [it] through social networks or other ones – that the understanding of technology is one of collaboration, one of sharing. And so, I think that really changes the way that people associate themselves and what they do with the technology.

I don't see it as much as the person in the corner hiding their screen or whatever; it just can't exist that way anymore because everybody has access to it . . . Now, if you want to know how to do it, you would find 50 versions of it, three or four different scripting languages, definitely one in Grasshopper. And so the way that you feel ownership over something like that, it's not the script.

Interviewer: Do you encourage that kind of sharing in your class?

Ronnie Parsons: Yeah, absolutely. In fact, in all the classes that I teach there is a shared cloud drive where everybody has access to everything that everyone else does. We used flickers so everyone in the class sees everything that everyone else is doing. If they have any questions, we say e-mail us or ask one of your friends. You can see if they're doing it already, right, everybody else. Yeah, the group goes further than the individual all the time. Yes, so we've already tried to emphasize that kind of shared mentality.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

Ronnie Parsons: . . . While sharing these certain kinds of techniques across projects is a good thing, being able to still remain critical of your own work is an absolute necessity, right? So I would say a bad thing would be if, for instance a student would, say, assume or not assume responsibility for something because perhaps one thing which was seen as faulty was born out of a pact or something from somebody else. So I would say the project and the kind of critical deployment of technology in the context of the project is still the most relevant thing. So, although I think it's good to share, I think the students always have to make sure that they understand.

Also, regarding the authorship, whoever wrote the script can claim the authorship if it's translated into a particular syntax; that's it . . . I would prefer for a student that's writing their own algorithm codes and really understood all of that, but for me if a student understands pseudocode logic for what they're trying to deploy, if they need to use codes that they found somewhere else, I don't think that matters because, at the end of the day, it's not about that, right? It should probably be about something much, much bigger, but it's tricky because, you know, in a way that when you're in this context of school, if you claim that 'I worked this code, and I did this,' then it's essentially plagiarism. So I think that students just have to be careful about how they claim authorship. They have to be very clear about 'I deploy this. I was interested in this, and I found a script online that allowed me to do it and have built on it.' It's no big deal.

If you think about it, did anybody have a problem with, let's say, the use of particular kind of transformation in Maya? I mean, those are algorithms that just have to be part of a software suite. Grasshopper, there is a whole chunk of code in there in the *meshing* that does all the stuff, and nobody has a problem with that. But that's just code that someone else wrote, right? So that's where I think it becomes very tricky. It's that at the end of the day, the thing, the code itself is not important; it's more about the student's ability to understand why you would deploy that particular way of systematic organization to a project and does it actually increase or decrease the fidelity of the overall agenda. If it increases, I can care less where they get it from as long as they're not claiming that they are the authors of that particular part.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Ronnie Parsons: . . . The students that I have in one of my classes – about 19, 20 years old, right? – they've been using Facebook for one quarter of their li[ves], if not a little bit more than that, right? Their understanding of the role that information plays and your identity as an individual is radically different than even mine . . . So in 10 years from now, whether or not Facebook still exists or whatever, there will be new more engaging, more, I'd say, integrated forms of social media. And so the students then in 10 or 15 years will have been using that for their entire life. The thing that I think is still tricky with some of these questions is that [they are] being asked through the lens of architecture.

And if you were to, say, take a trip to ITP – The Interactive Telecommunications Program, at NYU, right, the new media program – and ask someone these same questions, I think you get radically different answers because the way that we view technology is still – even though we think we're doing really advanced stuff – it's really antiquated in a way when compared to people who are working with computation design in new media, or even in sound, so there is going to be a pretty big difference in the next 10 or 15 years. I think the trend is yes that there will be even more pervasive forms of social media that will in effect change the way that people see themselves and identify themselves and the information, which means that when you start to propose cultural problems as a design problem at this context of studio, the response will be radically different. And I just think we're going to see huge, huge changes, really huge.

Interviewer: What kind of social media do you use when teaching?

Ronnie Parsons: We use Flickr, DropBox, box.com. We have nodlab, but it's funny because I feel that I'm engaged in technology. On a daily basis I work with CNC fabrications machines, I write codes, I work with parametric modeling, I blog every day, I work with a cloud-based apps. I am in technology.

When I talk to my buddies who are also in technology but in other disciplines, I'm like a dinosaur compared to them completely; they just can believe it . . . Because they're fully cloud-based, they are totally cloud-based; they are working with distributor processing systems. I mean, they're full on the bleeding edge of technology. It might just be because of the quality of their discipline, the tangibility of their – they are media artists, film as well, and photography, and so digitally based. The tangibility is completely different. But the funny thing is just that the scale of files, the complexity of the files, all are similar . . .

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Ronnie Parsons: . . . The cornerstone of probably everything I've been talking about is this idea that technology is important, but really critical engagement is the most relevant issue at stake.

So in every case, whenever we're working with students, we always emphasize they need to understand why particular uses and applications of different technological paradigms are relevant or not. That's always specifically within the context of the relative design agenda. So parametric design is the go-to, I would say, interface of the computation today. The parametric processes, thinking about the way that you might engage your design problem, might not necessarily lend itself very well to a parametric model, right?

There are other models of computation that are not parametric, but understanding when is that relevant or when does that become a necessity for the retention of history, become important, it could be from a standpoint of just technical issues . . . So is there a way to think about the use of a parametric model through the issue of memory, through the issue of inheritance? That's very different than writing code, which is procedural; every time you run it, you have essentially lost what you had before.

So, for me, I get excited when our students begin to recognize that and understand that it's a type of hotpot for radically rethinking what they assume to be a kind of given, a perspective technology. And the good ones, the creative students, are the ones who actually say, 'wow, that's actually a place where I can really find innovative ways of approaching a design problem,' because of the very fact that the design problem itself served as a way of critically examining technology, right? This is not happen[ing] that often.

Interviewer: Do you assign some readings?

Ronnie Parsons: Yes, definitely for the theory part. And I do that as early as second year, have them start with readings.

Interviewer: Do students think critically about how these technologies effect architectural representation?

Ronnie Parsons: . . . It's hard enough to figure this stuff out. Then you have the issue of innovation, and then on top of that you have the issue of radically reorganizing the entire thing. That's a tall order to be able to wrap your head around that because it is conceptually a very robust way of thinking, right? So I would say, yes, some students.

Interviewer: Do you believe the readings that you've assigned helped the students?

Ronnie Parsons: . . . You can offer the readings, help the students do the readings with enough time that they can actually go back to them, and then hope that they can then take the big leap, which is now [to] contextualize what they are working on with respect to technology, but in the context of the readings . . . The fact that technology is so pervasive at this point, readily accessible, students have more opportunities to actually through theory [learn] practice, right, and through practice [learn] theories because it's so readily available. So you can provide the reading and a stronger student can say, "wow, that is totally applicable to this thing that I am doing," and then actually through a series of practices begin to interrogate the critical discourse or the discursive . . . So yeah, in a perfect world I would say that we could assign a series of readings, we could have a series of exercises, and students would be able to connect the dots and the assumptions that you made as somebody who is older with different experiences coming from a different time in which technology was introduced to them. Your assumptions can be radicalized.

Interviewer: What are some of the reading topics?

Ronnie Parsons: I mean, there is always going to be something like systems theory–

Interviewer: Like Christopher Hight writings?

Ronnie Parsons: . . . That's one that would be a reference. Sometimes we'll just give like a short extra kind of a scientific paper, I mean, that's actually coming from a scientist. There is always that history of CAD and CAM so that the students can get their head around what the actual lineage is, what these things are coming from. It's always funny when our students assume that this stuff is somehow new in architecture. It's not at all, as we know. But, also I will say that there are readings that are really important that are supplementary, that are supplemental to the issues, not just technology. And if you take a look at our books, they are pretty broad, but all of it I think is really talking about the same thing, right? So in some cases, we have seminars. We'll look at readings from even from S M L XL, for instance, readings on Delirious New York, understanding the role that fiction plays, especially when you're starting to write code, things like that, right? Code: if anything, it's fiction.

So, it's pretty broad things that we have them read. [A] lot of it is through the lens of architecture, but we give a lot also that's coming from other places that begin to really start to understand the broader and cultural implications of technology. The problem of architecture is that we architects like to just go like this and [are] always just looking in and then finding references that are by other architects who are also looking at – or look at references from various philosophers who are writing these with architects who are also looking in.

It's changing a little bit more now. And I definitely think that the scope is broadening a bit, but there's a lot of really amazing writing that isn't in the media, really amazing ways of thinking about technology and understanding the world in a temporality of a city, through the lines of technology, a lot of really interesting ideas.

Interviewer: Is there a specific theory or way of thinking that influences our design, like for example the constructivism a 100 year ago!

Ronnie Parsons: Today there is much more of an emphasis based on performance. I'd say there's performance in the broadest sense and that performance may involve material performance, cultural performance, various types of economies of performance.

Interviewer: When I attend a jury, I sense that students are trying to master a software without a philosophical or depth in their design concept.

Ronnie Parsons: Yeah, I think you're absolutely… I believe that technology is born out of cultural desires, cultural necessities. The technology is the invention of cultural desire because we can't understand technology outside of the context of theory.

And if you do, you're actually not learning to interrogate technology, but rather how to just use it. At the end, I have no desire in that whatsoever. I want to, every time that I sit down and I begin to work a problem, be in a mindset that is open to what might happen outside of what I already have assumed. That's why I like using tools that lead toward the unexpected – pretend towards the vague or open-ended – because I want the technology that I use and tools that I use with agents with process with the various things that I bring to the world. So, in a way, I like to collaborate with the various tools and technology that I use. I don't see myself as an accessory of it in any way.

I see myself almost as a mediator, kind of somebody who curates a play, a range of various players of those things. In the case of CNC, maybe it's code, maybe it's material.

All of these things – I'm helping to bring them all together and through their conversation discover something which it did not already have. That's totally tied into my own views into the world, the way that I see the world, right? I wouldn't do that if I didn't watch certain films and listen to certain things. So, I definitely always have the students – I want them to understand that you might be using this and they might be using the same thing, but if you produce the same thing there is a very big problem. So one of the other things I always tell them: subjectivity should be projected within the objective framework you put out. So, if I run the same code that you run, the outcome will not be the same. It will never be the same, because I have certain tendencies and I have certain types of desires. I have certain ways of seeing things; they are different and vice versa, right?

And so, you know, something, which might be seen as a mistake by me, to you, might be the best thing you've ever seen, and it may take you on a wildly radical divergent trajectory. And so that is . . . important for students to understand. And I think that's had a negative association with technology, and actually the thing that you're making is a byproduct of the code itself, right? Yeah, if you build up an objective machine, at the end of the day, if that thing should produce something other than one thing, you have to be the person that decides which one is right, or which one is good, right, etc.

And so, your own desires are there; your own kind of strangeness, weirdness, all the stuff that is you is present. So, certain things might be amplified, or turned down, or whatever, one person versus another, and it's an important thing to recognize that because, even with that objective framework, there is still room for subjectivity. You're still the one writing the code by the way. You're still the one who is making all the decisions. But I still don't think that you are the only author because within the running of the code, there is an entire vague or gray framework that exists where certain things that you thought would happen don't – so then the code itself becomes an agent. You have to be willing to recognize that, guide it accordingly.

Interviewer: But you're the one in control, the one who guides it.

Ronnie Parsons: . . . So imagine – choose-your-own-adventure book, it's a great kind of example. And let's say you have an infinite choose-your-own-adventure. So at every step you can choose A or B or C, but you flip the page, but you don't know what's on the next page, right? You have A, B, or C, and you pick that, but you don't know what's on that next page, and all of a sudden, you're actually going down a path, which in every step you're making a decision of where to go, but you don't know where you are going yet.

This is why I think that we have them read from the Delirious New York. You can start to wander through a path, where at every step you're making a decision, but the decision you make – you are not knowing where you're going yet. It's like thinking about these processes. So with the code, you are in control of what values you change; you're in control of the decisions that you make about one thing being better than the other and things like that, and the next time you run it, you don't know exactly what you're going to get.

And so that way it's a kind of reciprocity, right? You and the code are going somewhere together. I think it's maybe off topic from what the original question was, but I do think it's really important to understand that you know at the end of the day [that] how they use technology is really, really dependent upon your agenda surrounding the technology. So just using technology alone – it's like use a computer; that's technology. You have your iPhone; that's technology. So, if you draft on AutoCAD, you are using technology, and so it's everywhere at this point.

But I would say that how you actually set up an agenda towards it – its critical use is the point; it's really the most important thing.

Interviewer: I found some students present their code, for example their Grasshopper definition, even they show that the architectural form that they have was a result of moving a slider in the code!

Ronnie Parsons: Yeah, I don't know why. So, what I think would be more interesting is if they created their own diagram of the Grasshopper file. Then instead of showing the nodes and what they connect to, they actually identify what are the critical frameworks present that are expedited by the model. In drawing that, what they do typically is find ways of subverting the model itself.

. . . When we actually engage technology in a critical way with a very specific agenda, oftentimes you find ways to subvert the technology itself, and in its subversion, we find ways of radicalizing the design problem itself because [at] the very beginning your agenda towards the design and its use of technology is already a way of subverting the technology. So you have this weird feedback mechanism already as soon as you step out of the panel and mutual engagement of technology, right? But it requires a certain mindset; it requires a certain attitude to go that way.

I would say in the diagraming, you have a system of checks. There are certain contingencies that how much of models is essentially a model of contingencies, right? What it allows for is just for the model to continually update so long as nothing is seen or found invalid. And in a model such as that, inheritance is always the thing which is most relevant. So you're seeing this right here is related to this right here. But that's related to this and this, and by the way, the guy at very end gets some of its values from the guy at the very beginning.

But what that means is that now you actually have a model where inheritance is happening, but not only in a very simple hierarchy. You actually have a nested hierarchy. So why then is one guy related to another but not to the rest. Those are very sophisticated issues. And by saying, 'yes or no,' in that decision making process of what is related to something else, they're making very, very important design decisions. So the diagram would actually communicate that, the whys, the critical thinking . . .

Interviewer: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Ronnie Parsons: With certain types of technology, which deals with simulation as well as information management, students [must] to be exposed to that and understand the relevance of that, just from a sheer point of view of economy . . . When they enter the workplace, they already have a very good understanding of the ecologic building and the various economies tied to the decision making process.

Whenever students are exposed to processes of fabrication, ways of communicating, it exposes students to a way of thinking about design, which foregrounds material efficiency respective to material of understanding how materials can be a place for design innovation. There's the professional practice courses and sustainable issues – it's definitely the responsibility of schools today and educators today to make sure that the students are well versed with that . . .

Interviewer: How might this definition of social responsibility evolve in the future in relation to technological advancements?

Ronnie Parsons: . . . Architecture, specifically, is an industry which is very vulnerable to shifts in the economy. And you've seen that the industry has changed because of that, and so in the future, I think that we'll see more and more ways of integrating the issues, which are the responsibility of the architect as a person who creates things for a society, builds things for society, and then technological advancements . . .

When we look at some of the innovations that are happening in practice today, you can see where the schools and academia can radicalize those things and actually forecast 15 years into the future, well beyond any we've seen today in practice. I don't know when it's going to happen because practices are moving so fast these days. And there is a mandate in practice for there to be a much higher degree of sustainability. Building information management systems or competition is all the time as a mandate, and at the end of the day, what that does is essentially cuts better, allocates resources, essentially saving energy, also greater efficiencies in all the various economies involved in building.

. . . I think that projects are getting more complex, timelines are getting shorter, more architects are graduating, lots and lots have been graduating . . . It's very different than where it was 10, 15 years ago. So you have to respond to that.

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Ronnie Parsons: 90%. Yeah, I mean, it's very high.

Interviewer: What are the primary factors that you believe may hold back those faculty members who have not adopted, or do not use, advanced technology or its paradigms, within their design studio?

Ronnie Parsons: Lack of experience.

Interviewer: Are they from a different generation?

Ronnie Parsons: Different generation.

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation?

Ronnie Parsons: Yes, absolutely. That's a cornerstone of the Pratt Institute.

Interviewer: What are the opportunities these technologies offer? What is lost by their use?

Ronnie Parsons: Yeah, that's definitely an argument, that somehow the computer is not a tool that offers the same sort of tactility that a pen or a pencil does, right?

No, I don't think we have lost anything in vision or craft. If you look at the Bartlett, there are drawings that are completely done in the computer that are incredible, incredibly crafted drawings, where no pen or pencil was involved. I mean it's just like the idea that somehow the computer offers some sort of lower fidelity in terms of tactility; I think [that] is not the case.

Certain processes which are done by hand can help in the understanding of very abstract concepts, which are largely taking place in the computing environment. But I don't see them as two separate things at all. I see that you model, you draw, you paint, you make music, you build things, you work with machines. I just see it as all one big ecology of making, and all of it is part of the process of conception.

I think that through processes of computing, processes of thinking through the world, through the lens of technology and vice versa, you can radicalize design ideation, right? I don't care if you are manually algorithmically building something or if you're writing code; I don't see there being any difference at all. There is no one tool better than the other. There are efficiencies, sure, and there are certain kinds of sensibilities that emerge in one versus the other. But at the end of the day, it's the user, right, that's going to need to make decisions about the various tendencies and peculiarities that emerge.

I think it's more about a way of thinking about the world. And if you're doing it manually by hand, you're doing it with a computer, or you're allowing the machine to do it for you, I don't see there being really any difference. I see all of it as a crafted process as opposed to a crafted artifact . . . It's a way of thinking about technology and because of the fact that you think about its use in a particular way, that means that the things that you do with it are by default critical, as you're already critically avoided it.

. . . When somebody, a student, who has always had a computer – in a way that the computer is really singing as a fully integrated aspect of their lives – it's a totally different paradigm, absolutely. So older conceptions of design ideation, who knows if they apply anymore, and some students are able to think in lateral ways that are actually bottlenecked by processes of the hand. Other students work way better in the process of the hand, and it actually adds a level of intuition in the computing environment.

The best way to kind of engage students is to really allow them free rein, to be exposed to many different ways of working and then begin to find their path through those different ways.

Interviewer: You still have the foundation course at Pratt?

Ronnie Parsons: Yes, we still have a foundation course in architecture . . . The computing environment might not offer a new way of thinking about things that you'll discover with your hand at a later point in time. That's why I'm not that keen on models. That's an old model, to think about it today. Because today, to think that you would need to support the same Bauhausian model, I think this is a little bit crazy.

To assume that you would still today need to work through a model that is actually from an entirely different point of cultural time is a little bit crazy to me because that makes certain assumptions about the intelligence that exists today, which is radically different than the intelligence that existed then, right? So models of design ideation and conception today are completely different because cultural information technology today is totally different, right? So that's why I think it's really important for students to be exposed to a lot of different things, and then through their own subjectivity, through their own kind of sensibility explore what works best for them. And in that way they won't have this mentality that somehow the computer and the pen or pencil are different.

They are the same; it's all one big continuum. And there are different tendencies, and you have to decide which one is the best fit for whatever the design or whatever that larger design issue is . . .

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Ronnie Parsons: Yes, so BIM is now going to be everywhere, right? All of the studios of the third year comprehensive will now deal with BIM. You'll see all schools will start to shift into that, right? It's an easy place to find it, to place it into the curriculum. Everyone has to do it; the NAAB, National Architectural Accrediting Board, has made changes that actually require you to have been in some place within the architecturally accredited institutions, so that's tied absolutely to the economy, right. So I would just say, easy, yeah.

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Ronnie Parsons: Funding is always an issue. I think schools are becoming a little bit more creative, like looking into industries that exist in and around that school, right, and seeing if they could tap into that to extend to workshop into other workshops.

. . . There is a need for schools to respond to the request and desires of the various people who contribute financially to a school. Whenever a school hears that we need more students to have Revit experience, the likelihood of a class dealing with Revit has increased, right?

That's not necessarily something that's specific to Pratt. I mean, I think that happens everywhere, right? . . . Different economic downfalls, spur kind of innovation in practice, and the building information management (BIM) paradigm became significantly more important after 2008, kind of like an adrenaline shot, and because of that architectural offices had to be very much quicker to adapt to that particular paradigm . . .

. . . That trickles down, then, into the schools. And all of a sudden now you have a whole lot of people who are graduating, but they don't have the skillset to be able to work in offices with BIM; the offices bear the burden of their training. It's a dense network of relations, and definitely, I mean, schools respond just to make sure . . .

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Ronnie Parsons: . . . You can't be graduating students who don't know how to . . . think in terms of a systemic approach; you just can't . . . Students are going to offices, and when they are hired, they are expected to be able to slip into a framework, which is already fully deploying technology, fully implemented technology. I mean the paper-based studio doesn't exist anymore. They can't exist; the engineers won't even take paper joints anymore because of liability issues.

. . . Offices that are up to speed or getting up to speed are the ones which will be more resilient to change in the future and more easily able to bounce back from shifts in the economy. And so, students need to be able to have the skillset to go to a workforce that is changing very, very quickly and adapting to change very, very quickly. And an educational institution has the mandate to send students to the world ready, to not only be critical of the things that they do and be active in terms of the placement within a lot of social discourse, but also have the ability to do all that, to be able to actually slip into a workforce and use the tools and technology that will allow them to go further than where they were within the school. I definitely think it's hugely important. Ethically important.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Ronnie Parsons: . . . One of most important things is for a student to go beyond the use of technology and actually to be able to critically engage the technology through the lens of a cultural problem, which is essentially design studio. It's a kind of incubator for design, for ideas surrounding cultural issues, cultural problems. In the past, the use of technology alone was somehow able to validate whatever came out at the end. I think that has to go away. We really have to go well beyond that and start to be very critical of not only the use, but how it's used, right? And what affordances does it actually provide or does it actually cause problems? . . .

There is nothing worse than being on a designe review today and sitting through five hours of people talking about technique. And you never actually get to the issue, which was presented at the very beginning whenever the instructor read the abstract or design problem. So, somehow we skipped over the problem; we got into the technique, and we stayed in technique. And what came out is actually not an answer to the problem, really, even a kind of thorough investigation into the problem, but rather a series of trial and errors with some sort of tool . . . The technology [must be] seen as something which is part of a bigger ambition, a broader ambition surrounding the design problem and not its solution itself. And that to me would be a good thing.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Ronnie Parsons: I think you brought up couple of really interesting points about the role of craft, right? . . . To go further into the nature of collaborative work, collaborative tools, shared authorship, and things like that because that's kind of the centerpiece of technology today, like the special social media type based applications . . . More and more and, as we said, earlier collaborative practices are really being sought out in the studio environments . . .

Interviewer: Are you familiar with Brett Steele's Architectural Association Design Research Laboratory? I don't know if it is still going?

Ronnie Parsons: It is. That's actually a really good example, that each year the students have access to the library from the previous years. And so that, the research that they do, isn't from the ground up; it's actually built upon the previous research, and so this idea of authorship is not important, right? Technique is not important; the type of technique is not important because if you're building upon a platform, you are expecting to go much further. In order to go much further, you have to be critical of the platform itself. So at the end of the day, I think, for me, that's the main thing. I mean, technology is here. It's everywhere. Students can code now, students can use parametric modeling, they are assimilating, they want to know how they're looking at video tutorials, they go and watch tutorials, they can download tutorials and learn from it. It's everywhere, right? So we have to really emphasize the why a lot more, because the how is done. How do you do that [is] not existing anymore. Do you want to know how? Go online, spend two minutes. Why are you doing it is the big one.

What are you doing with it, why are you doing that is really the conversation between students? And it's building up more. You already see students are far more critical today than they were even five years ago, far more critical. I did a lot more whys today than I did five years ago.

Well, you'll see. I mean, when we have somebody who has had technology present in their life always and not – I mean, really present on a daily basis, almost an hour by hour and minute by minute presence – the wows and surprises are not there anymore.

Interviewer: Thank you, Ronnie, and I look forward to see the changes at Pratt.

Ronnie Parsons: Yeah, you're welcome.

16) Skylar Tibbits

Interviewer: Regarding the influence of technology in contemporary architecture education, do the models/paradigms associated with digital technology shape or inform pedagogy at MIT? . . . Other [schools], for example, use information theory, network theory, and some schools are a mix of different technological paradigms . . . We passed the era of mass production to an era of mass customization. Now, I believe, we're in an era of information. So that's why the information technology, theory, philosophy, I believe, is shaping architectural pedagogy and practice.

. . . My perspective is that there's not an overarching or top-down perspective on the paradigm that we operate in, but rather my tendency might be slightly different than my faculty neighbor and some other faculty. And, in that sense, it's much more a mixed bag of technological interests influenced . . . I'd say it's much richer or much more diverse.

So, when we teach core studios, there may be three of us to four of us depending on that year, and each one might have a different take on how technology influences pedagogy, although the projects would be the same. The faculty has different perspectives in their own work. So, I think there's definitely an overarching tendency towards using new technology, whether it's software or hardware, machines, materials, whatever. But I'm not sure that there's a paradigm or an agreed upon conceptual approach to those tools. So, we always use the same tools, digital hardware, machines, materials, but we use them or we conceptually think about them in different ways.

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school? How are they integrated into the curriculum?

Skylar Tibbits: First of all, the school is extremely diverse. It has a number of different tracks. So there's an M.Arch program. There's an undergrad program, which is not an accredited program, so it's a four-year program. Then there is a SMArchS level, so master's of science, and there's different focuses: Aga Khan, history, theory, building technology, computation, urbanism. And then there's a PhD. So, all of those are totally different. What I'm talking about mostly today is the M.Arch program, which is probably the largest portion. And I don't know about the exact numbers, but generally it's a major focus of the school. That's where we have the core studios that then go to option studios; they have a number of electives.

. . . So anyway, the undergrad and the M.Arch, they have a number of studios, and within those studios, I would say the exercises are where the paradigm or the model that you're proposing bleeds through. And I wouldn't say it's so straight forward like we say, okay, this is the systems theory project, or this is the unit aggregation project. One of the projects that the M.Arch does is an installation project. And so, they are looking at how to mediate some environment, mediate wind, mediate program, mediate materials, light, or whatever it is, and using new materials or machines for the technology. And that comes into either describing surfaces and components or unit aggregation or subtractive, like Boolean processes, or erosion.

So some of those paradigms that come up over and over again probably bleed into that, but I wouldn't say that it's overarching. It just comes out depending on the instructor, depending on the exercise, etc. I mean, there are other seminar courses or workshop courses that people take. How to Make Almost Anything [is] a course that I teach at the Media Lab, and that talks about all different machines, code, electronics, materials, composites, casting, everything fabrication. So that's not a studio, and that's a course that undergrads, M.Archs, SMArchS, PhDs can all take, so some of that comes up there . . .

Interviewer: Is How to Make Almost Anything an elective?

Skylar Tibbits: The How to Make Almost Anything is certainly elective. In the M.Arch program, it would be an elective because it's not a core studio or a core requirement. But in the SMArchS program, it's one in their H-level, hard level courses; it's a main course that they could take. So it depends. It's open to anyone in any school at MIT, any level. Even faculty take it.

Interviewer: Do you teach electronics in it?

Skylar Tibbits: Yeah, we teach it in the class. But there is a huge set of students and faculty. There is usually, I think, 30-plus students, and then there is like 10 TAs, three faculty inmates – it's a big course. So that goes [through] everything, from a water jet, CNC router, laser cutter, 3D printing, 3D scanning, casting, composites, computer programming, electronic sensors, motors, interface design in one semester. It tends to be usually the SMArchS or PhD with a few M.Arch and maybe one undergrad. But that's a course that integrates the technology heavily, but again less on a mode of thinking within that technology. Neil Gershenfeld started that class about 10 years ago, and through my relationship with Neil, I developed my research trajectory. And Neil is certainly specific about where he thinks this technology is going, but not so much as it dictates the type of projects that students produce. The students are totally free to produce whatever. Some students produce musical instruments, some students produce units and models and architectural projects, some students produce robotics, some students produce machines. It's totally open. We're not constraining the type of project they do.

Interviewer: How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?

Skylar Tibbits: . . . There are clichés that are developing in the discipline, like gradient and aperture and unit aggregation and surface project and glossy, gooey geometry, sort of SCI-Arc style, Southern California Institute of Architecture. So there are all these different tendencies, therefore, and I guess that's what you mean by the paradigms . . . Some of the fabrication equipment was brought to MIT initially through Larry Sass, from

J. Meejin Yoon– for the faculty that are still here. But it's been around for a number of years . . .

Larry Sass' work is very different from Meejin's, or from mine, or from William O'Brien or from Nader's – all of us have very different ways of working, although we might use the same technologies, same machines. And the design computation group has been using computation and digital technologies for many years. But I don't think it has really influenced that 'here is a strand of projects that come out of MIT,' whereas if you look at . . . the type of project that you see coming out of SCI-Arc, you could probably categorize into one sphere. For better or worse, I'm not saying it's any better because of that, but it's a bit harder to categorize a type of project coming out of MIT.

There are certainly people that were responsible for implementing things in the department like new machines or – Nader definitely is responsible for having this huge fabrication lab and hundreds of thousands of dollars spent in time and investment in developing our machine, material, and technologies. And Larry Sass before that [was] doing that, and Nader [has] also [been] kind of changing the layout of the department physically, like the space that we have and the infrastructure there and bringing in certain faculty. But again, it's more like the infrastructure and resources that are influenced rather than the type of project. And certain faculty members that are here – like Mark Goulthorpe will teach a studio, and Meejin will teach a studio, and their studios will be very different . . . And even within that the students are influenced by the faculty's research, but I still wouldn't even say it's correlated to a paradigm of work at MIT.

It's really diverse, the type of work that's coming out. Maybe the closest thing to that would be the discipline groups within the SMArchS programs. So the design computation group is very diverse within itself, but maybe the type of projects are much more similar. And there you have fabrication projects and robotics projects, differently coded, computer science ones. We have kind of computation applied to many different genres, and then in urbanism [it's] probably a similar thing, building technologies probably. So maybe that's where paradigms are more prevalent, but in M.Arch it's really diverse. I mean if you look at the type of thesis projects that happen when you're graduating M.Archs, it's all over the spectrum – everything from urban scale to housing to materials and solar collector, one-off little object kind of thing – so that's all over the spectrum.

Interviewer: In my research, some historical architecture schools in Germany and Russia introduced a new design theory, principles, vision – do you see something like that at MIT?

Skylar Tibbits: Yeah, I'm not sure. If you put a hundred projects up on the wall and you scattered a number of MIT projects that I hadn't already seen before with a number of projects from other schools, I'm not sure I'd be able to pick-up which one is from MIT. And that has nothing to do with the quality of network or the technologies we have or the skillsets. I think that it's more arguing we don't have a single thread of a design paradigm that we work under, and I'd probably argue that's a good thing – and it might be sort of an MIT culture. You'll see that almost every building is interconnected. There is not really isolated buildings except for a very few of them.

So there is this mentality that one discipline bleeds into another discipline and one scale shifts to another scale and one technology shifts to another, and we have this machine shop here. And we think [it's] really awesome because we've always created machines, but you walk two doors down, and they have the exact same machine shop, if not better, in material science or in mechanical engineering or in AeroAstro or in cancer research or cognitive science. They have extremely similar machines doing totally different things, and part of that is similar. Many of our M.Arch students or undergrad students go through all of their core requirements for their own degrees and their undergrad degree. And before they are taking studios, or simultaneously, and they are taking brain and cognitive sciences classes and philosophical classes and physics classes and, I don't know, AeroAstro, all these things. And then they are taking studio, and so that's this crazy diversity.

We have some students that tend to go towards one discipline, other students that go to another discipline. In the end, you have thesis advisors from many, many different departments, your co-advisors, so you always have an advisor in architecture. So it's harder to see those design tropes, what may be like repeatable or iconic design tendencies that technology is producing. We certainly could talk for hours about what those are – and I know them just as well as you do from around the world but I don't know that MIT has its own trope that shows up. And maybe that's a good thing because of the diversity of interest and disciplines that we have. But it's unbelievable how interconnected MIT is, and I think architecture still has a long ways to go to take full advantage of that. But maybe that's part of the reason we don't see it; it's because we have this diversity.

Interviewer: What do you think are the positive and negative implications of the use of these technologies?

Skylar Tibbits: The problem is that . . . technology produces novelty in the beginning, and technology is novelty. But then quickly, it's not novel anymore. So we look for new technologies, or we look for more novel ways to use the same old technologies. So it's sort of this rat race trying to catch up with the next, the next, and the next.

The good part of technology is that it does allow you to kind of break paradigms, step out and make new advances, new opportunities. It's like a new lens on [that] which you looked at before; it might allow you to shift scales, it might allow you to shift materials or do things faster or more efficient, so it's a great design collaborator. It's a great opportunity, but it also gets you in the cycle of always trying to do the next. And it gets you in this arms race . . . One school is trying to compete with another school to get five more robot arms. And then, oh, SCI-Arc already got five, so we need six. And oh, we have six robots, and then we have a water jet plus a CNC, plus we have these printers. And everyone is just trying to build up their arms race thinking that they will attract more students or that it will be better for the school. I'm not really saying that we're engaged in that directly. I'm sure that we are in some non-direct way.

. . . Another danger with the technology is that we think if you have these machines, your school will be better, but I don't think that that's the correlation. It's like machines are novel. Buy new machines; they will produce new novel projects. And I think that's a little bit of a false hope . . . I think both machines, information, and, let's say, digital technology – so coding and opportunities in the computer software – that allows you to communicate. I can write Python script in Rhino and have similar code and collaborate with the molecular biologists in California. So we can talk a similar language, which is hard to do with a very specific software. The chances of them using Rhino or using AutoCAD is so slim when you go to another discipline, but the chances of them understanding a fundamental programming language like Java, C, Python, whatever it is are really, really high. It becomes as language of communication across schools, global, anywhere. So that's awesome. But also these tools . . . allow you to change scales. Python doesn't care what scale it's running at. It doesn't care if I'm going to produce things at an inch, at a millimeter, at a nanometer; it doesn't matter . . .

So, it allows me to collaborate with people in different disciplines, take on projects that are outside of the traditional architectural realm. We have a really great influence in collaboration where before we would never have thought, 'What is the designers' role in molecular biology or studying protein strands or DNA or cancer research or anything like that or space structures or whatever it is?' But because we have these tools, I can now collaborate with people across disciplines. And then, similarly, instead of just saying, "Oh, we're great. We're architects; we can do a lot of stuff," you can look more humbly and you can say, "What does a molecular biologist know about construction?" And I'm starting to do that now and say, "Look, molecular biologists study construction every day, and they look at how viruses build themselves. So they look at how DNA unzips and zips itself. And they look at how protein strands fall over there." They look at all these other really, really interesting things, but many other disciplines look at things that are transferable to architecture. And if we can make the problem extremely explicit – here is a problem in construction, here is a problem in materials, here is a problem with organizing space – you can transfer those to other disciplines and learn from them, and they can collaborate with us.

So, technology certainly allows us to change scales, and I would hope that's an opportunity that MIT could or is taking advantage of and could in the future take advantage of. And I think it would play up to that point where there is not a single trope or design paradigm that we're working in, but there is a diversity of scales. There is a diversity of technology, so there is a diversity of applications. I'm not sure we're there yet, but I think that's the hope.

Interviewer: How do you believe technological models shaped architectural pedagogy historically?

Skylar Tibbits: Technology has always been there, and we've always inherited technology in architecture and helped to shape that technology. I can't think of an example where architects have been at the forefront of producing new technology that went outside of our discipline. But rather we've normally inherited other technologies and for the better. Now when these technologies are leveling disciplines, allowing them to be on the same plane, we have an opportunity to produce technologies or collaboratively produce technologies for problems that are at different scales than we normally work at.

Interviewer: Do you think it did add to critical thinking in design? Are we critically thinking about designing in a higher level than what we used to?

Skylar Tibbits: I'm not sure. I think we're more naive than we allow ourselves to believe. I think that we get blinded by new latest technologies, and whatever it is – new materials, new machines, new design tools, whether it's the parallel rule or the CAD software or the rendering engine or the code or whatever it is. Machines – we get blinded by them, and then we think it's a whole new universe. And it's also because of new students and new faculty, and new generations, and it seems like there are cycles. In every cycle, you forget about the previous cycle. You think you're in a whole new world. You have new technologies; it's limitless. And then you realize, well, mass customization wasn't really true. And it was this hope that we've thought was exciting, but actually it's really a problem in assembly. And it's not actually new world; we dealt with these issues with previous technologies, so it's just a different paradigm. You know, the pencil is actually not any different than some new technology. They both have their constraints; they both produce the similar tropes or tropes that emphasize the constraints of the tool.

. . . But history repeats itself, and we forget about history. I don't think we're the best at learning from the past. I think we're just big kids in a toy store or big kids in a candy store. And new technologies come, and we all want to play. And we think we're being really serious in producing great research, and some of us do, but in however many years, we'll forget about the research we've produced. And there'll be some new technology, and people will be producing that.

So, again, pedagogy keeps going. I think, for the most part, pedagogy doesn't get so stuck in those cycles. Research does, practice does, but pedagogy in general is a bit more critical of them. Any school that just takes on one technology wholeheartedly is going to be left in one of those troughs. And they're not learning from the previous one. They think they are so unique, and they are not going to be around at the next cycle. So any major school that's been around for however long –AA school in London, or MIT is a great example, is one of the first [architecture] school in the U.S. It's hard to say that the AA is defined by this particular stance, and at certain points, it had more emphasis than others. But it wasn't created because of one paradigm maybe, so pedagogy needs to have a bit more of a critical look at technology.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years? How?

Skylar Tibbits: If we're talking about the relationship between pedagogy and technology, I don't know that the relationship between those two will change. Pedagogy should certainly be open to new technology, but it also should be critical of technology. And it also should be linked to practice because if any one of those three things – like technology, pedagogy, practice – if any of those things [is] too strongly influenced, then you get stuck in another track. And technology is going to advance, and then the technology might crash and be the biggest lost hope or the biggest failure.

You don't want to track any one of them too closely because then your pedagogy is linked to one of them. You want to have a diversity of those things. And I think that's considered the role of pedagogy, to prepare you for industry, but not too much, right? You also want to have other opportunities to prepare you for new technologies, but not too much because there is always new technologies coming down the road to link up with core design agendas. But those go into cycle, so you need to have a few of them.

I'm not sure the relationship between pedagogy and technology will change. Yes, technologies will certainly change. Yes, industry will change. Yes, design agendas will change. But will the relationship change? I'm not sure.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

Skylar Tibbits: So, you said before that there was mass production to mass customization to information. But I would have said information is what led us to mass customization because it was only the ability for us to write code and the ability for us to use code to manipulate machines that allowed us to do mass customization.

I think if we're going to say there's information, there's two phases of information; there's the pure information in the conventional sense where information was digital, and now information became physical in fabrication, which led to mass customization, which I think was kind of a failure, or at least failed hopes that we thought mass customization would lead to all these existing things. Well, also the bigger problem with mass customization is that it's a sorting problem. And yes, we can produce every panel. First of all, you find efficiency, but second of all, it's in the construction problem. And that leads you to the fact that, sure, you can produce it, but do you really want to produce every panel the same? So then you try to go back to design and figure out smart ways that you can have a small subset of pieces that then those subset of pieces can go together in infinite ways. And that's where aperiodic systems come in.

Now there is a new paradigm, which is information that's going outside of both digital machines and digital software, so it's physical objects that can contain information. The application of that is in construction, and that's where I'm really interested. And – just like the problem with mass customization is a construction problem – it's not a manufacturing [problem] because you have design analysis, manufacturing, and construction. Design analysis will come extremely far. Technologies are extremely advanced. Manufacturing, same thing, we can produce almost anything.

You see Gramazio & Kohler, and you see many other people looking at automated construction techniques. So I would say that's the next thing. I'm certainly interested in that. And I would say I'm less interested in pure robotics as the solution because I think it's less scalable. But I'm more interested in that idea of information and how do we embed information into physical parts. So how do physical things compute? How do they communicate with one another? How do they make decisions? How do they respond to energy so they can construct themselves? Which certainly gets to the idea of Gramazio & Kohler, but less about sort of brute force top-down robotics that can build everything, but rather robots or people collaborating with smart materials.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

Skylar Tibbits: . . . You have different types of skillsets that become beneficial. You have different types of backgrounds and students that allow them to excel. And when before we had the influx of fabrication machines and everything was about material, I would say a software savvy or computer savvy student would probably excel because there is the paperless studio and there is a digital revolution happening.

But now you have students that need both, and they need to be extremely savvy on the computer software code, design analysis tools, as well as machine. So you have students that have a background, their parents ran fabrication shops and had these machines in their backyard, or students that know woodworking and know materials and have the sense of that, and they need to know both. The machines, materials, and the software side has become seamless so they can pick it up pretty quickly . . .

Interviewer: Do you offer a paperless studios at MIT? Or did you mean the tutorials on a blog maybe for your students, where they submit their assignments?

Skylar Tibbits: I wouldn't say we have anything that we call paperless studio. There are certainly classes for students to take on technologies – and How to Make Almost Anything is one of them – but again, it's so physical every week. They have to produce physical things as well as digital things, and they have to be able to write code. And they have to be able to use electronics, and they have to be able to use machines and materials.

And in other classes they might learn Grasshopper, or they might learn Rhino and Python, or they might learn whatever. But usually those classes aren't only about one software. But they're learning about geometry; they'll learn Grasshopper and that allowed them to propagate geometry or whatever it is.

But an interesting thing about the SMArchS and competition or SMArchS and PhD or even undergrad is that, when they want to know these tools, they go to the discipline that invented these tools. So they'll go to computer science if they want to learn a code. They won't take an architect's representation of computer science; they'll actually go to computer science. And then it's on them to be able to translate it. Many students are now going to mechanical engineering to learn about machine design rather than fight their way through and learn it on their own. So it's kind of a different paradigm at MIT where you just go to that department to learn it. But there isn't really a paperless strategy here.

Interviewer: Do you use a blog to teach with your physical studio?

Skylar Tibbits: We do both. Some of the software tools that we've used are Rhino and Python, Processing and Grasshopper, and we do in-class tutorials. We also have the TAs give tutorials out of the class. We also send them links where they can look up tutorials and things like that. But the class itself is 100% not emphasizing those tools.

The class/course I'm talking about right now are three different design studios. And in each one of those, the tutorials were a small portion of the class for a week or so, so that they knew the tools. But we're just trucking along studying many other things in the design studio, and they have a specific project that they're using for it. So it's not like it was about that tool, but we needed that tool in order to implement something for the project.

Interviewer: In the geometry class, do you encourage sketch models, hand drawings, or is it all done in the computer?

Skylar Tibbits: Well, that's not a class that I teach; it's a class that Joel Lamere teaches. But obviously in all studios they need to know geometry. They need to know simple design principles; they need to know programmatic constraints, site constraints, materials, machines, all those things. So that's what we're trying to do develop. I mean, students draw by hand. They use two-dimensional software, CAD, Rhino; they use three-dimensional. They use code, and Grasshopper, and Processing. They use CAM software to manipulate the machines and different machines and materials. Sometimes they use analysis software for environmental or structural or whatever it is.

We use everything. There's probably more of an emphasis on digital machines than there are on hand machines like hand woodworking, or metalworking. There is probably more of an emphasis, and that might have to do with the fact that the fab lab is so relatively new in the past few years. But we do everything.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Skylar Tibbits: We have certain team-based design projects, and we have individual projects. I don't know that the technologies are what influence those abilities. It's not like when you use a machine you have to use a machine with multiple people. And we have protocol setup where they use the TAs or they use the fabrication lab manager, and MIT has a policy where the students use the machines. It's not like other schools that I know where the fab lab manager or the TAs will run your jobs; you have to run all your jobs.

And we have a pretty open policy. Students use the machines on their own, and sometimes there is some buddy system where a student has to be there. But it's not like the software or the fabrication and machines, dictate that it has to be team-based. It's again much more on the studio or the class that they're taking and what the project is and whether it's teams driven or not. The implications of the fabrication lab have probably bled into the fact that we usually have some project in the core that's installation based, which is a large-scale project that usually requires teams. And that's mostly just the scope of the project, and the teams can produce more.

So there is definitely a team project, usually in the core studios. The other thing is that there is new software coming up that's much more collaboratively focused. A friend of mine who is a graduate of design competition group, Kaustuv De Biswas, is starting a company that makes collaborative software, so it's all in the browser. We can all be designing; it's as if we all have the same Rhino file open, but it resolves all the issues of saving and that sort of thing. And so you're in the browser. You don't have the software, and we can all be manipulating, editing a model. And we can all have different modeling apps. So I could have an element app running; you can have some sound analysis; someone else could have some physics base. And we're all running it in the same model on the same viewer.

. . . If that came in full force, that software, which is called Sunglass . . . that would certainly influence the ability for people to collaborate, and not only collaborate within your school, but collaborate across the world, across the U.S.

So, SCI-Arc or UCLA or CCA up in San Francisco could be collaborating with MIT, and we could be collaborating with AA on the same project having core studio. So you can imagine these faculty that are visiting faculty, whoever, stop flying around the world, teaching multiple studios at Columbia, UCLA, and Vienna, could have the same studio, all working on multiple models because they have a software; they can do that over the browser . . .

Interviewer: And do these technologies positively or negatively affect peer interaction/learning within the design studio?

Skylar Tibbits: Positively, because there [are] so many technologies for students to learn now: drawing, 3D modeling analysis, Presentation, Illustrator, InDesign, Photoshop, Rhino, any structural environmental analysis, AutoCAD, CAM software, Mastercam, whatever it is, plus the machine controls itself, plus we're going to get into electronics, plus we're going to get into code – tons of tons of technologies.

It automatically proposes that students will get better at one or two of these things. So you will have students that tend to be the fab (fabrication) gurus. You'll have some that are going to gravitate towards code. So you start to see these guys helping each other and/or interacting with one and another. And sometimes when the team-based projects come together, you want a few of these people who are good at different things to team up. It's positive. And it's a necessity because people can't be good at everything, and there's starting to be such a plateau of technologies that they end up having to collaborate. But you also find people that are able to do both, or navigate easily within any one of them.

Interviewer: Is there a trend here? Where do you see this leading in the next 10 to 15 years?

Skylar Tibbits: The collaborative software might make it more global, less about institutions. And if you look at like the TED-Ed and the MIT Harvard EdX, The Khan Academy, The Stanford online, you see all of these new modes of education where I think it's flipping the educational model, where in class is the homework and at home is the lectures.

Many institutions or many groups, organizations, are starting this thing, and it all started from Khan Academy, from Sal Khan. But you see MIT is picking that up, and I'm sure many other schools, if they are not defensive, are going to try to jump on that. And that would totally change things, and that might be able to link up with this collaborative software, where the name MIT and the name Harvard and the AA and all these things are going to mean less because people are going to get education in many more places too.

The schools themselves are going to mean less, but it's about linking globally; that means more. So maybe these collaborative software tools, maybe the fact that fabrication machines are almost ubiquitous – they are almost in every school, everywhere. And there are fab labs. Neil Gershenfeld has hundreds of fab labs all over the world that aren't associated with the schools. And there is a fab academy that Neil set up. You can't have a degree program if you don't have the location, and like Khan Academy, it doesn't have a location. So you can't get a degree in Khan Academy, but that doesn't make sense. And soon I think that whole degree paradigm is going to change, and in Khan Academy, you will get a degree that's just as prestigious as you would from MIT or all these places. And same thing with the fab academy. So it's becoming a sole distributed network of education. And these technologies – the fact that physical, digital fabrication technologies are almost ubiquitous and software is now going to be collaborative in the browser super light, like I was saying, across disciplines, across scales – it's going to be less about these iconic centers and more about distributed education. So that's maybe how technologies can become collaborative in the next 10 years or so.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Skylar Tibbits: I think we always emphasize the fact that if we're in one particular studio, this project is not about a laser-cutter project. This project is not about a CNC fabrication project, but this project is about an installation that mediates space. And your group, a few faculty sitting down at that group, say, "Okay, what is your project about? What are the conceptual goals? What's the site? What's the scale? What's the material? How do you use the right machine for that material? What does the installation do in the end? How does it interact with the user?"

We don't emphasize one particular machine over another one for one particular project, but rather using the right machine for the right circumstance. And I think that allows them to be critical to say, "I do really have an excitement to use this machine, but for this project I think the most beneficial or most opportunistic option would be [that] particular machine."

So we ask them to be critical there. I mean, it's hard for the students to be critical as well as absorbing the information. Usually, the criticality comes only and hopefully in their thesis. But it also comes many years after school, and that's where they start to formulate what their actual perspective is, their research agenda. I think it's a little too much for the student – to ask the students to be extremely critical of all the stuff that's being thrown at them as well. It is foresight into what's happening down the road. I mean, the students' job is really to come and absorb and then after school to critically evaluate and then form their own opinion. And maybe the thesis is that turning point . . .

Interviewer: But then how do you evaluate them? I mean, how do you say, "This is a good design project"?

Skylar Tibbits: Well, we don't have to evaluate them based on their critique of technology, or based on their critique of pedagogy, or based on their critique of paradigms or trends or tropes. We can evaluate them based on their conceptual agenda of the project, the deliverables of the project, the quality of those deliverables, how they present it, whatever the program is, how it interacts with the people or the site or whatever . . .

Interviewer: Do you teach students to push back on and innovate beyond these paradigms? How so?

Skylar Tibbits: Some of that is the instructor's role to say as students fall into tropes or fall into common paradigms that we see time and time again. As instructors, we've seen it many, many times, and we've probably done it ourselves in the beginning as well. So when a student is using a new technique, new technology and new project, new scale, new material, whatever it is, they're going to fall into the common trope. And then as an instructor, you can say, "Look, this is why this has happened in the past. These are the benefits, these are the downsides to what's happening. Let's critically go past this because here is a reference; here is a precedent."

If you're talking about a material transformation or aggregates or whatever, I've had a student that produces a model, and you can very quickly point to a reference in the past 5, 10 years that here's a project that implemented exactly what you're talking about. So look at this project – what were their goals? How far did they go, and not that you need to run away from it? – because someone else has done it, but critically evaluate and how could you push it further? Why do they fall into that, is it a useful trope that you fall into? And what new advances could we take on it? So it's not like all that's cliché; we can do it to run away, but evaluate why it's happened before or where are you, what you actually want to get. And not that we just want to look like everything else that's been produced, but critically pushing forward.

Interviewer: Do students think critically about how these technologies effect architectural representation?

Skylar Tibbits: . . . What the students are trying to do at the representation is best represent their project and in some unique way, probably more so unique to themselves and unique to their classmates than it is historically or globally . . . It's more like they're trying to do the project the best they can do, their mind is totally in it, they have no sleep. They're trying to represent the project the best they can in the given short amount of time that we give them. And another thing that's similar or common in the U.S., but different globally, is that we have one semester projects, so like three or four months of that is a studio. We don't have year-long studios like 16 month studios like DRL, has it, the AA or Vienna where you have one instructor for how many years. We don't have that. So we have one semester.

There is not enough time to critically evaluate everything to really evaluate how a new tool, new technology has been used historically, how that's used globally, how it can innovate on that, plus representation, how it can have a good strong project and et cetera . . . That's our job as researchers, and our job as teachers is to investigate that, evaluate what's happening, form our own critical opinions, produce our own research, which then floods through the school. Teach studios in line with some of those perspectives, not force the students to do it, but kind of critically evaluate their projects based on [it] . . .

Interviewer: There is a worry that we're teaching students to master a tool, that we're teaching them to limit themselves with an interface of a software environment, [that] there is no critical thinking – are we really limiting the students?

Skylar Tibbits: . . . And the students perspective might be, "Oh, I should present my code in Processing, or I should present my Grasshopper definition thing because that's what's innovative here," whereas the instructor [is] saying, "No, the project is the goal here, and we think that the project paradigm or more conceptual underpinning is that. And the software is not the innovative thing; it's not the focus of the studio." But for the students the software is the new thing; you know, in every studio, they have our project. And they're all going to be different, and they're all going to be innovative. So some of that is a miscommunication on what the studios intends. And some of it is the students just being proud of what they've been able to learn, a little bit naïve on what has happened or what's going to happen, also a little naïve in the interest of producing things that look like the other exciting things that they see in AD and the rest of them.

Students have an interest to learn what's new; students have an interest to produce aesthetically what's the latest trend. So those types of things kind of entice students to present the tropes that we see. It's the instructor's role to be clear about the intensions of the studio, why we're using a particular tool, that this studio is not about that particular tool, that there will be more tools in the future and there have been other tools in the past . . .

A lot of times we have the students produce diagrams, and those diagrams explain what are the inputs, what are the parameters, what are the results, what are the design decisions in that. They don't show me a bunch of codes; no one is going to read that. Don't show me a Grasshopper definition, but what's the agenda and the core decisions that you made in that code? Because it's not that the computer produced it. You also have that the students think, 'Well, you know, it's not my fault. The computer produced it, or this one iteration is only one of a thousand; you can't critique this one.' You also have that. And so, I think we try to do a good job of explaining, "No, at every point, you're building up the tool, and you're banking off another tool. And those decisions that you've made – you should outline those decisions and why it is the way it is."

So we usually try to have them make diagrams or explain that through a physical model or through drawings on what they've done, and we're never saying, "Post your code, post your Grasshopper things, show us how cool and innovative that thing is," because that's not the project; it's the logic underneath that project.

Interviewer: Yeah, when you think about the Bauhaus and Vkhutemas basic courses where they teach students sculpture, abstract thinking, geometry, shade and shadow, texturing all by hand before they go into designing. Some schools now adopted this foundational course.

Skylar Tibbits: That's certainly how I was taught in undergraduate. We don't have time at a five-year program for undergrad. You can do that. Your first year, you don't talk about architecture; you talk about reputation and hierarchy and geometry and color and line weight, the representations, and stuff like that.

That's exactly how I was taught. In a three-and-a-half year program, you don't have enough time to do that. You can't use the whole year. So that's one problem. But second, I don't think that we emphasize that because we do work on abstract projects, but within the very first studio, we start with abstract projects. We get into different technologies and materials and work on an installation project. And by the end of that three months, they're working on site with a program with an enclosure. So they're working on architecture in the first three months. And they kinda work their way into that, trying to isolate different problems that they're going to investigate within that architectural project, but we don't seclude them and necessarily trick them into it, I would say.

So it's really a hybrid model. I think there is some use to that because it also slowly breaks down your preconceived notions of what architecture should be when you work on other things. And you focus on possibilities geometrically, materially, representationally, or whatever. It stops you from thinking this is what architecture can be and this is only the amount that architecture means. You use all the things that you learned, and those things now reinvent your definition of architecture. So I think some of it is useful, but I wouldn't say that we fundamentally bank on that.

Interviewer: On social responsibilities, do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

Skylar Tibbits: We're not burdening them with heavy-handed sustainable responsibility or environmental responsibility, material responsibility. I mean that definitely comes up, but I wouldn't say that's the overarching agenda of MIT, at least from my perspective. I think the machines – they want to be responsible materially, efficient, not wasting so much mostly because they don't want to spend a lot of money and because they don't want to spend a lot of time on the machine. It already forces them to think critically about the way they use materials and how they nest them on the sheets and the customized problem that we talked about before. So that's inherent, and people are already thinking about that.

Environmentally, it comes up, or programmatically that comes up in more of the comprehensive studios where they look at one project for a whole semester and how that responds to the site, how that responds to environmental structure, that kind of stuff. So I think it comes up, but it's not really that it pushes a new social responsibility on them. We don't have a core agenda of that . . .

Technology allows you to be more responsible, but it also allows you to be more irresponsible. And I don't think that software, machines, are forcing people to be responsible, environmentally, materially, socially. But if you want to be, you can, and you probably should, sure. We should all be more responsible, but it also allows you to focus on other things, and people find responsibility in many ways. I'm against the moral argument that it becomes a sort of a religion, an architecture religion of responsibility, and I'm totally against that.

So I don't think anyone should be critical or criticized based on their responsibility or their moral obligation to do something. I mean, otherwise you might as well join the church of responsibility. Certain people can take on the agendas, and technology allows you to find your own agendas in a different scale. I might find an interest as an architect to have responsibility to help at the biological level and use some of the things I learned in my architecture training to work on drug delivery systems or whatever it is, but someone else might work on sustainable building practices, right? . . .

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Skylar Tibbits: A high percentage of them, like 75% or something. I am not sure of the exact numbers. But it's not like there is a requirement . . . If a student found a way to use welding metal or wood tools, no one would be against it . . . And we might give tutorials and demos, but they are not required to use it. Students' projects are more important than whatever tool they utilize. We think that this is a good tool and could be useful for the project, but if you're not comfortable and your project doesn't want it, you don't need to use it. But a good majority of the faculty here utilize it themselves in their own practice and offer tutorials or ways that students can use it in their studios.

Interviewer: What are the primary factors that you believe may hold back those faculty members who have not adopted, or do not use, advanced technology or its paradigms within their design studio?

Skylar Tibbits: People teach what they believe for the most part, right? And people don't want to teach what they don't believe, and people teach what their practice is involved in and teach what their research is involved in. And some people aren't interested in that technology. Or they don't have people in their office like that, or they work from a different time period. Or is there a different technology that they are interested in?

Interviewer: Could it be a generation issue?

Skylar Tibbits: It could be generation, but we also have senior faculty that have really cutting edge practices that are using these technologies, and they have people in their office interested in it. So I don't think it's only generation . . .

Interviewer: Do your faculty members think critically about how digital technologies affect the possibilities of architectural representation?

Skylar Tibbits: In studios the quality of the model, the way they build models, the way they produce drawings are certainly critically analyzed. And, like I said, that's how we evaluate the students' projects . . . 'What have you produced as a representation of your project?' Obviously that's linked to the tool that he/she used. And what was possible, or what were you limited by? So we certainly think about that. And I would say the quality of drawing – two-dimensional representations have dramatically decreased because of software tools, so you can look at plans sections and drawings. And getting students to actually construct drawings is an endless battle because it's much easier to just make 2D and change some line weight. So for students to understand and think in 2D or construct in 2D is very different. And maybe some of that we are forcing and we shouldn't be, but that's a lost representation at the moment or a paradigm that's quickly evaporating. But there are new opportunities that are emerging.

Interviewer: What are the opportunities these technologies offer? What is lost by their use?

Skylar Tibbits: Technologies are offering new ways materials can come together. And new precision in physical making, new precision in digital making, new complexities of models, a new amount of information that you can take in the environment of the structural analysis, mechanical systems, new geometries, material properties in those geometries, the link between physical and digital, all these things . . . Traditional means of representations in terms of two-dimensional representations, are probably suffering significantly, but some might argue that maybe you don't need them, and others might argue that the technology has made us a bit lazy . . .

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Skylar Tibbits: Not so much that is shared with the department. I mean, there are certainly economic constraints on the machines we try to buy or the materials we utilize or how much students were charged for X, Y, Z. I mean, in general, I think MIT is really supportive and not constraining that. We just set up this fab lab; it is a beautiful equipment. And some capacity – and for the most part students aren't charged for fabrication. They're definitely not charged for time; they're charged usually for materials only for printing 3D and 2D. For laser cutting – that they'd bring their own materials; they're not charged, CNC routers and things, water jet and things. So the students are relieved of the economic burden, and there are certainly constraints there . . . The school is progressing significantly since Nader and Meejin Yoon stepped into play and since I have been here as faculty, and it doesn't seem like economically we're constrained by that. But I wouldn't say we're swimming in riches either.

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

Skylar Tibbits: The profession and the studio are diverging a little bit. Pedagogy and professional practice are diverging, and a part of that is useful because practice is a lot about the economy and practice relies on efficiencies and relies on other constraints that pedagogy doesn't. And so it's useful for academia to be relieved of those pressures. By relieving some of the constraints, you can find new opportunities and push the field. So conceptually, academia could be leading whereas practice is implementing, and it's a little bit further. But at some points it's useful for them to converge as well. I mean, if you just look at software like Revit; it is certainly not flooding academia, or at least at MIT and most of the major schools that I know, Revit is not a major software. And who cares about Revit? Really meaning that who cares of it's coming into academia or not? But I think it's an interesting indicator of different pressures that industry is taking. And Revit might be a useful technology, but it's not a useful technology in academia,. It's great software, sure, but it has no real added benefit academically. The question remains is whether these two tracks are going to diverge significantly in the future, or will they come back at certain points? I mean you were talking about the mass customization argument: that is really an issue that practice and pedagogy are addressing, and addressing in different ways.

And certainly, Zeiner and large fabrication companies are using extremely cutting edge technology probably more innovative than any academic institution to produce real world practice projects at a large scale. So fabrication is crossing both. Software is crossing both. Probably software goes from academia to practice other than Revit. Almost every firm in the country is probably using Rhino to some capacity; many of them are using Grasshopper or Python, at least the most innovative ones. And so somehow innovative software trickles down, and they realize that some of the exciting things they could do design-wise can also influence practice. But at the end of the day, the constraints that the client or a developer might have on the efficiency or the number of units that a building can get and the rent they are going to get or the payback on this or that of the same constraints is something that academia doesn't have. So I think it's useful for them to be separated a little bit, but you want them to rub shoulders at some point.

Interviewer: In the past, academia used to shape practice. Do you see that now?

Skylar Tibbits: No, not directly. I think they are shaping each other [in] indirect ways, but I don't think academia changed practice. Right now probably academia has some influence on practice. Practice has a whole different set of constraints that has some influence on academia. And it's kind of reciprocal, although they aren't diverging tracks or parallel tracks. And there is some crossover, but they are a bit different at the moment.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

Skylar Tibbits: Can you give me an example?

Interviewer: Like you say, "I don't want students to graduate without teaching them how to use these technologies."

Skylar Tibbits: M.Arch is constrained by NAAB, so there are requirements that we need to have for NAB. And that's another discussion about – that gets back to this Khan

Academy model, this distributed model, and what's the role of the NAAB in the future of this? I mean NAAB is going to be totally irrelevant or should be irrelevant when we have this whole distributed model. And another question: is NAAB irrelevant today? Potentially can NAAB keep up with the developments and technology developments and design developments in practice? Potentially not. So – but anyway, that requires certain general constraints on what we can teach at the introductory levels so that students have requirements on general technologies and theory and design perspectives. So in some way, you cover your bases because of NAAB, and that's somehow useful, although it constrains you in other ways. And then I have some other critiques on that, but at the end of the day, after you have taught some fundamental building blocks and ways of thinking and ways of solving problems and ways of approaching projects and machines and materials design technologies – yeah, it's up to the students, and students will gravitate towards tendencies. And at the end of the day, we are going to get a diverse spectrum of students that graduate.

Yes, we know they have gone through these requirements. Do we know that they are experts in all of them? Probably not. Are certain ones much significantly better than others at certain technologies? Sure, but I don't think we have any real ethical concerns that they haven't been trained in certain things because we have across-the-board requirements at the very beginning. And I think we have pretty strong lower level studios, and we have all the full-time faculty, or the faculty that are here year after year teaching those studios. So, it's not like we have visiting faculty that are teaching whatever the hell they want in the first studio. So, we have a good grasp on what all the students are getting or graduate with, but then there are options levels on their thesis that are going to gravitate towards some interest.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

Skylar Tibbits: How we get out of this cycle of novelty like we talked about before, and out of the cycle of the tropes that we fall into, and utilize technologies to cross scales and cross disciplines? That's my real interest in the future, and that's a question and also an opportunity that I see.

And I also think about how we translate all of these new technologies out of the design and analysis field, out of the digital field, and out of the machines and fabrications field into the construction field. Because if they stop at manufacturing, they won't find their way into practice, or they won't find their way at different scales, or they won't find their way in different disciplines. So, they stay a design academia exercise. So, the ability to cross into the construction fields or logics for assembly, I think, is critical. Those are two things I'm really interested in. But I think if you ask any faculty member here, they'll probably have different perspectives on what are the critical issues between technology and pedagogy.

Interviewer: Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?

Skylar Tibbits: I don't think so. I think we've covered a lot of stuff!

Interviewer: What do you think of shared authorship, a student may borrow someone else's code/script in his/her project?

Skylar Tibbits: . . . I'm never emphasizing that people should go online, download a code, download a Grasshopper thing, use it in their project, and hide the fact that someone else produced it. I'm never emphasizing that; I'm always emphasizing it's a way of thinking. Sure, I will give examples. Some people can use them to study it, but the hope is that students have no desire, just like I have no desire to go online and find a code for something because I'd much rather spend my energy writing it and figuring out how it works. And the amount of time that you spend finding the code, understanding the code, getting it to work with your specific application, debugging their stuff, you might as well just find out how it works and write it yourself, or try to think about what the underlying logic is to write it yourself.

So I'm certainly of the perspective that we teach logic and ways of thinking with any technology, software, machines, material, physical computing stuff and that students should have the excitement and have the desire to produce their own tools or subset of tools from that way of thinking; that's never about taking something that's already there. And it gets into a larger question about open source and what's the relevancy of open source in our world, and I've kind of gone full spectrum on that. I was really in favor of it in the beginning and am critical of it now. I think part of that comes if you look at least in design, when we're talking about it in the design world, and if you look, the people that are really taking advantage of lots of Grasshopper definitions out there and lots of code out there are not the same people who are producing those types of codes.
. . . I think it gets to a point that it produces a form of laziness. It's just it's easier for someone to find someone else's work than it is for them to produce, and they're afraid of taking on the problem of having to figure it out . . . There is the argument of authorship, but aside from the authorship, I think it's more of a way of thinking. We wouldn't have to talk about the authorship if we would just write it ourselves . . . Processing is a good example; it has huge libraries. And Grasshopper is another; it has huge modules that you can plug in there, super powerful . . .

I guess my critique would be two things. One is that I would question the users' ability to think in that manner . . . If you don't understand what's happening there, you're just copying and pasting; you're making a collage of other people's work that you don't even understand yourself, and your motivations are aesthetic copying . . . Your project's probably going to be weaker quicker by downloading someone else's because the only thing we're going to be able to with that tool is what they allowed you to do, and you don't know how to edit it.

So, I think this is sort of the natural evolution of technologies that, when you first pick up a pencil or a child picks up a pencil and you watch it, the child is going to show the constraints of the tool. And it's going to act wildly, and then it's going to be able to have some control over the tool. And so the first things you produce with the new tool shows the constraints of that tool . . . It's about the ease of using these technologies that, whether this is good or bad, code had a barrier to entry. And whether it's a fear factor or a difficulty factor . . .

But other tools, let's say, Grasshopper have erased that. Within a day [anyone] could do something pretty useful or pretty functional in Grasshopper and may not understand anything about how that tool is working or anything about the logic. And that's really exciting . . . In terms of pedagogy that's really constraining because you are actually giving people a shortcut to not understand what they're doing or how they're doing it. And then it's just more about the effects of what they're producing, and that's also another spectrum that we could evaluate projects based on their effects . . .

So, I think there is definitely a positive in the democratization of the design tool that allows people to enter there, and many people go to the limits and then learn code through that. So it's definitely a benefit . . .

Interviewer: Thanks for your time. I really enjoyed it.

Skylar Tibbits: Sure.

17) Thom Faulders

Interviewer: **Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform the pedagogy at your school, California College of the Arts?**

Thom Faulders: Yes, I've been teaching at CCA for a number of years, and so the tools that are at the forefront keep changing. And, it wasn't so long ago when we started with an all Mac platform, and so we're all in this sector, work stuff for drafting. And Form-Z was the main modeling tool that was opening up everybody's eyes to new possibilities, and of course that just keeps changing. And it seems like that changes more rapidly; more recently it was going from generative components, and we were starting to get people to figure this one out. And then all of a sudden Grasshopper just ran through the studios like wildfire. So, it's less about – and probably some of your questions, they're overlapping here – but less about a linear progression through the proper use of tools that I see the bigger picture. But at CCA, I see it more as a messy workshop where we're invested in all of it, and very much in a non-linear way. And I'm talking about through the studios and also the various professors and, of course, therefore with the students. So how does that shape the pedagogy? Well, we're using all of it. And as we use all of it, how we consider what it is that we can design or solve is – those questions are being asked, and we can explore it in new ways because we have different tools.

Interviewer: **And Professor, is there a specific module or a paradigm of digital technology informing design pedagogy at California College of the Arts? For example, at ASU the technological paradigm that is informing the studios is more about the general systems theory where they emphasize the units creating the whole. But is there a specific technological paradigm that is informing your pedagogy, or is it a mix of different paradigms?**

Thom Faulders: In my opinion it's a mix right now. And I'm not the spokesperson for the school. So, I suppose you could speak to other faculty that would have a different opinion, but we are almost purposefully running several different tracks, whether it's more built in technology, meaning at the scale of building or energy and sustainable issues or kind of mapping and diagramming and urbanism and the others. There's various bundles, you could say, of thinking that we run concurrently, but that said, I think what ties it all together is the fact that we are on the West Coast and near Silicon Valley. And well, that doesn't have a one-to-one relationship with the school, meaning we're not through direct sponsorship or what have you, but it's very much in the air of social media, the possibility to reinvent how we do what we do through technology, and I think it's that spirit which is maybe a little bit of a broader one than what you just outlined there at ASU, that lends one to this kind of spirit of innovation and experimentation, which again is very much in the air in the Bay Area politically, socially, and also technologically – that courses through the department.

Interviewer: **How are they integrated into the curriculum?**

Thom Faulders: There's not one easy answer to that because we have about a five-year undergrad degree, a three-year and a two-year graduate degree, so obviously it's various departments, or various programs, sorry. But in general, these tools are ubiquitous. It's not an area of study; it's not something that's off in a corner. I doubt it's like that anywhere these days. But all faculty are engaged with this, and it's kind of the day-to-day means of production and exploration in the tools that we use . . .

Interviewer: **How long have these models/paradigms informed your curriculum? Who introduced these models to your curricula (professor, administrator, student)?**

Thom Faulders: Well I think it's both. I think what's nice is that I prefer to see this as kind of a bottom-up emergent condition of the use of these tools. Of course we introduced a lot of this to incoming students, but where it really gets interesting is when there is a kind of a hacker – or, maybe we can say, an exchange of ideas and programs and plug-ins and possibilities of all these sorts of things that I think happens again at the bottom-up level through students working with students, with going online and sharing and finding out. And I think it's really exciting when . . . people are trying to find new possible ways to circumvent the tools that are already out there.

That's what I mean by bottom-up. It's not prescribed, but it is kind of innovative and inventive. And I think therein lies the possibilities of what the students can bring to the table – that we might put the basics out there, but at least the ones that are interested in this and take it on, they're able to corrupt in a good way the tools that are out there, the basics. So then it's kind of like this feedback that informs what it is that we can do with this that can inform pedagogy and so on and so forth. So I see it's all of the above.

Interviewer: What do you think are the positives and negative implications of this?

Thom Faulders: We are talking technology in curriculum and pedagogy, and that is a fairly broad term. But I'll play it in a slightly different direction. One of the best things that incoming students bring to the studio and to their education is that they show up with a laptop, and we require that. And they spend all of their time on their laptop, and that's great because it's obviously – it's not a laptop; it's that networked system. That's the best thing, and it's also the worst thing because they spend all of their time on this laptop. And it's a fairly small rectangular screen, and they are rotating potentially very large projects that should be the size of the city block or whatever that are representationally being explored as something that's the size of your fist. When you put that right on your screen, yeah, and they're twirling this thing around with their mouse. And I'm coming up to talk to them, and they ask me, "Well what do you think of my project?" And all I can say is, "How would I know?" And this thing is this little model that it's like spinning around, this three-dimensional construct. It's scaleless because we can make it whatever scale we want. It's beautiful and maddening at the same time.
And so I think this is something that currently we're trying to negotiate because if we are

ultimately trying to design something that we occupy, then it's larger than us. If it's always the size of our fist, kind of rotating, we have this kind of distance to the thing and how do we get inside of it is something that I find is an obvious one to think about. But for students that are coming in to thinking about architecture for the first time, it's less obvious. How do they get inside the thing? How do we start to understand it not only as a digital model but as a construct and as a phenomenal condition? And that, at this point in time, needs to get outside of this flat screen presence. So I don't know if it quite answered your question, but it's in that territory, I think.

Interviewer: **So regarding the issue of scalelessness, how can we fix that? Should we teach them model building, things with your hands, before we introduce the laptop?**

Thom Faulders: No, I think I actually have been doing it with my advanced students. And we work digitally, and again, I'm using laptop loosely to really mean this kind of rectangular screen that we're on. But I have been getting a bit wary of looking at project after project after project when there's no drawings; there's no overlapping presence. It's just a series of images and folders and PDFs or whatever on a screen.

And so we've been working that way more or less for part of the semester. Then we completely switched gears and have been making two-meter tall models of – they're still representational. It's a bit different than, say, a digital fabrication type of one-to-one experience. It is representational of the building, but now that has become larger than the person that's creating it. And so aspects of phenomenon, gravity, and simultaneity of materiality, all of these kinds of things now start to become a really interesting test, and now we flip it, and it is not just this, again, this thing that sort of sits easily in your hands or on the tabletop. But now it is kind of looming over you. And for me, I find that a really interesting combination. They're both necessary. One is not better than the other, but it's this back and forth feedback. So, this is something I've been looking at more recently.

Interviewer: Well, you mentioned the sense of scale is one of the negatives of the use of technology. But is there any positive?

Thom Faulders: Well, I think it's all positive, actually. Yeah. What it allows us to do [is] to visualize what we're thinking about. [That] is only positive. And it's incredible, and it's powerful. And given a little bit of tools and training to students, what they're able to now start to conjure up, I think, is there's no negatives there; it's kind of amazing. So it's not a negative; it's just to know how to start to understand it more fully.

Interviewer: How do you believe the technological models shaped the critical thinking in architecture pedagogy historically?

Thom Faulders: New technologies in the capabilities of early 20th century building, and before, of course, always provided a kind of paradigm shift of possibility. And if we think of again, building systems, integrated systems into architecture and curtain wall systems and structural systems, all of a sudden there's this whole new realm of possibility that designers really could start to ask interesting and pressing questions about the built environments, historically. So, what about today? And obviously, that's been done when it comes to processes of conceiving architectures. It's certainly being done in manufacturing. So we're very much in this interesting fast-paced era right now. It's kind of amazing. And at the same time – I'll flip to a recent example of a project I just finished. It was a fairly large scale private residence, and all of the systems – the building systems, entertainment systems, heating, lighting, everything – is on what's known as the Savant System. And it's all connected to your iPad. So it's all highly networked and efficient, remote. Everything that's smart.

And guess what? So it's highly technological, but has nothing to do with form at all, or space. It has only to do with kind of the occupation of that space. For me it was one of the more interesting aspects of working on this project because it opened up kind of some new territories. And yet, as we go back to designing the architecture that informed Xerox, we start to realize that the technological thing, which has to do with how we might occupy space, may or may not necessarily inform how we design space. So, technology isn't going to be the only feeder, if you will, of input. I don't think it ever has been, but we could err on the side of thinking that technology as we're talking about it at the moment might be this thing that is the driver of architecture, and I don't think it's quite so simplistic as that.

Interviewer: Do you believe that this relationship will evolve over the next 10 to 15 years, how so?

Thom Faulders: Well I teach a seminar where we spend a lot of time looking forward. It's fun to do. I work with grad students that are at this point where I think there's only future, right, as you leave school. There's the future of building. And I'm really invested in trying to get them to think very proactively about this instead of, "Oh, I just need to learn the tools so that I can get out there and get a job." It's like, "Yes you do, but let's really—." We're the drivers of where this can go.

That being said, one, of course – obviously it's treacherous to try to predict the future. It will happen in ways, of course, that are unexpected. Things that we put out there today will be co-opted in other ways. But I think for students perhaps in pedagogy moving forward in 10 or 15 years, my hope is that it has to do with pressing environmental and social and global concerns, but it's not an engineered way of finding solutions.

For me, architecture is still very much an art form, and it's a cultural endeavor. And I think therein lies its kind of purposefulness and its optimism and a bit of its humanity, and I think as we start to load up our teaching with tools, modeling systems, and mapping systems and energy, output modeling, eco-tech stuff, I start to sit on more and more student reviews where they're like an automaton, describing how their project is simply solving problems. And it might have solved those problems, and it can still be a piece of crap as far as a piece of architecture.

. . . But if we're not almost a bit more adventurous, I think, in how we solve these problems, then it doesn't sound so interesting to me. I think architecture historically – we were just talking about this – has been able to navigate the arts and technology together. The questions that we're looking at today are weighted on the technology side. I, for one, would argue to counter that more on what I'll just call the art side. And if we meet in between, I think that's where architecture continues to be interesting. If, down the road 10 or 15 years, we are addressing even more so issues in a very, very provocative and interesting way, then I think we have a way through it. Otherwise, we won't have an audience.

Interviewer: Do you believe, Professor, that we have to provide the students classes that talk about social studies or environmental studies?

Thom Faulders: Yes, of course we do. And I guess, as I'm saying, technology won't solve all. This is something that is a phrase that has been repeated often over the years, over the decades. But it's a player. It's a necessary way to do this. And if we look at, again, energy, population issues, or whatever, technology, social networking, efficiencies, innovations – those are technological ones. Don't get me wrong here; it's absolutely necessary, but it's not the only thing that's necessary. And I think where we take this is what else do we bring to that table. I guess that's what I'm putting out here at the moment.

Let's just say, one example might be again kind of this bottom-up condition that I talked about a few moments ago of social networking and empowerment, and we see this in multiple ways, whether it's Kickstarter, 99% movement, or what have you, or what's going on with the three Russian singers that have been arrested. Right through social media, there's all these demonstrations around the world. This kind of, what Thomas Friedman would call this kind of flat world. I think we'll, interestingly, [be] seeing more and more and more of this and how this starts to influence the production of architecture.

It's interesting; we'll see what happens. But this could be a surprising – just as film, music, other industries that have been locked in and kind of top-down, isolated seats of control – I think architecture, of course, is very different. It's not just being put out there by some large companies, but maybe there are ways that things get co-opted and how this stuff happens that we can't even now see. I'm purely speculating, but I guess what I'm getting at is I don't think it's only through more sophisticated building, modeling techniques, and higher memory in our computers that we'll just take care of all this. I think it's going to be a little bit sloppier than that.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

Thom Faulders: Well, I love just to be provocative with different students to think about things that might get a bit uncomfortable. I like to introduce them to a lot of Ray Kurzweil, and where he's looking further out in 10 or 15 years, but to a point where this kind of post-human condition, where we are very much a condition of and integration of technology. And, as he goes on to prove, we already are. We're using language, which is a technology. It's a tool. It's an invented tool. Certainly, we use plenty of chemicals internally, through medicines and drugs and what have we. And so when we see an artificial appendage of some sort or an implant, then we feel a bit threatened, but we forget about the fact that we are already in amalgam of various technologies.

So, if we are going to focus on technology at the moment, and if we are looking forward, at what point do we become even more a synthetic amalgam of these things that we are creating? And if that's the case, and I'm going beyond your 10 or 15 years or whatever, one could ask, "Would we still be living in a ranch style house, or a mission style stucco, a suburban tract house or not?" The most bland kind of living condition? Actually, we probably would be. We might be post-human, but we might be living in really bland conditions. But of course we want to continue to ask questions. Well, what does this mean for cities and the built environment, and when does the built environment become maybe post artifice – becomes a little bit more intelligent? And we see plenty of intelligence, embedded sensors, all this kind of thing, in our architecture in cities today. And at what point is there a blurring where our environments become so smart we're not sure what's material and what's simply an operating system? And it's the same with us. What's meat and bones versus an operating system of some sort?

Interviewer: **On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the CCA?**

Thom Faulders: . . . I'm amazed at how students today are able to keep it all in this . . . compact little laptop here, right? So this whole world is really somehow dense not only in here, but also in their tools. And I come from a different background and era. We're all different anyways, but the stuff that we created wasn't only in virtual space but was in meat space, Gibson's sort of gravitational space. So I find that to be very different. Secondly, with a laptop, a student doesn't need to be in a studio. We have an urban campus, so studios are not the only game in town. Your friends are there. If you're not there, what else are you going to do in town? But we are in a dynamic, vibrant San Francisco so there is plenty of other kind of pulls on your attention, and if you can be doing this late at night somewhere else on your laptop when you are modeling or whatever, I think students are readily compelled to do so.

So this can be a breakdown of this architecture as a social endeavor during the creation of it and almost this individual one. No, that's not entirely true because while they might be home or whatever doing this they are also constantly online with each other chatting or whatever. And so I think that is a bit of a change. We certainly talk about that as faculty, and I find students, especially the kind of studios I have been running, they do need to be there. There's kind of a nice reward that comes from that. It's also a shared experience, and that's kind of a bond. And the tools that we do have that we have been talking about today are so vast that it does help to have a group think when you get stuck on a particular program or process or whatever. So I think there is a bit of a change. That would be one change of how studio culture exists.

Interviewer: **I mean, they need to show you their project; you need to critique them in the studio, right?**

Thom Faulders: Yes, absolutely, absolutely, absolutely. And I think they need each other. I remind them of this constantly – that in some ways they're going to get more out of each other, as through competition, through shared ideas, through accidents, all of the stuff that every single company in Silicon Valley, all these start-ups and this kind of lateral office, non-hierarchical, open, right, kind of office plan mentality, which is everywhere in the Bay Area and elsewhere. But there's so much talk about this kind of stuff here with technology and social media and start-up companies. And especially as an art and design school, we already have that mentality. So why would the students want to walk away from that when that's something that large companies are fighting to try to create? So it's something that we talk about. We experiment with what are the good models for how to set up a productive studio culture. Every school today is largely driven by economies and [is] asking questions about online education. But I think, "Sure, why not?" That could be another attribute to how we do what we do, but I don't know how the experimental condition of a studio environment – I don't know why that should go away. I think that it's incredibly powerful.

Interviewer: Do you provide the students with a blog? I mean, do you create a blog to post tutorials, ask them to post their assignments?

Thom Faulders: No, I see them quite often. I see them three days a week, three afternoons a week. There is a lot shared at work, so the last thing I need to do is, after being with them for you know five hours and late at nights, start blogging at these guys. Get some work done.

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

Thom Faulders: . . . I enjoy the fact that school can be quite an amazing opportunity to explore one's individual possibilities. So to have a group and team set up over and over and over again in the studio environment is less interesting for me. There's the arguments, "Well, this is [what you're] going to be doing when you get out of school blah, blah, blah," and that's right, sure. But school isn't work. School, especially graduate school, should be very intense and very difficult exploration of ideas out there in the world and how you might stack up your own ideas against those. And I'm interested in that for the students. So I have no problem with kind of working with the students, more or less as a set of individual beings that are working, as a group, of course, 'cause we are in a studio environment [working] towards a common goal. And I do also really believe in that. It's very much a studio course and also seminar; it's really kind of a think tank of course, right? So it's everybody's ideas together that really starts to set up the thesis of the idea that we're trying to explore.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

Thom Faulders: You know, I think probably they have less room to question what it is. They're just trying to figure out how to explore. So broadly speaking – and of course I'm an educator so I'm critically minded – but broadly speaking, in studio, I've tried to get them to do as much as possible in terms of output and the possibility of production, innovation, given whatever means that are at their disposal. In seminar, I think that's a better chance for us to step back a bit and discuss what's exciting and what should be critically analyzed about new technologies, new paradigms, and so on. So I think I try to divide out since I am able also to teach seminars.

Interviewer: What kinds of seminars?

Thom Faulders: I've been teaching – this semester it will be called Out of Control, and the past two semesters or three, I think was called Lifelike. Those previous ones were broadly speaking looking at artifice and more specifically biotechnology and where this kind of bionic and technologic – that might be considered being more artifice – where these come together in our world, which is architecture. And through a series of readings and thinking about the future and case studies and so on, we're able to, I think, really spend some time speculating without necessarily needing to pull a project out of it. So, again, this is where we can, in a highly open-minded and speculative [way] these students to think forward and think beyond their comfort zone to where things might seem even a bit strange. But if we don't allow ourselves to do that, I don't think we're trying out enough ideas. And, of course, we do this in studio, but at some point you also need to produce some of the ideas. So there isn't as much time often to really speculate theoretically.

Interviewer: So the seminar is a theory focus. There's no design project.

Thom Faulders: There is very little design, and instead of theory, I would call it more concept. I'm not a theoretician or historian. I'm an architect and one who practices, and so I am more comfortable presenting them as concept seminars where we really try to push concept and, again, through critical readings and analyses and whatnot. But, per se, the work is not design work. It might encroach into that. We're creative thinkers, but it's really a seminar kind of format.

Interviewer: And it was on biomimicry?

Thom Faulders: Yeah, it touches on this.

Interviewer: What about the one for this semester? Is it the same?

Thom Faulders: Yeah I'm still putting that one together . . . It's a set of ideas that are just brand new to the students, which of course makes sense. So, this semester I'm really trying to focus on some of these conditions where the outcome of architecture, or the possibility of architecture is one that is not necessarily put in place, or designed, or positioned as form, but it's the result of a series of conditions or operations and is therefore unknowable, and hence the term Out of Control. This overlaps with a lot of what we're talking about today, and it's something that I simply find fascinating. It's something that has coursed through also a lot of, depending on the decade, a lot of art and sculpture and work that isn't necessarily a building or a piece of architecture, and so I'm trying to overlap into some of those territories as well, but really to look at this not only conceptually, but what it means today for architecture and might mean in the future. So, that might all sound a bit oblique, but perhaps that's where we're headed with this.

Interviewer: At some architectural juries that I've attended, I see some students can't present the reasoning to their use of that Grasshopper definition, for example, that they have on their boards. Do you think this is what we're missing – the whys, why we're doing what we're doing? The reasoning for us to use these technologies?

Thom Faulders: Yeah, it's not one or the other. Just because you use this doesn't make it good, right? Just because it might be a complex Grasshopper script or whatever, the result might still be not so great. But we're here to explore and to try out things and to experiment. And these are students; they're learning. And so it's good. To me, I think it's important to have this script. And if they can walk one through some of their decisions, I think – a long time ago it used to be a series of ink sketches on some yellow trace or something and overlays and, "This is how I've diagramed this thing."

So it's simply a way of getting behind the thinking and to understand some of the processes and the logics and the leaps of faith and what-have-we that are made along the way. And so I have no problem with this. Where, again, students can often be surprised is they may have spent a lot of time trying to work out a script, and here it is. And I think you have to give them credit for doing this, but we also need to talk about, "What is the result?" And it might just be a horrendous piece of architecture as measured along other terms, you know. We have to leave that open at this moment since we don't have a project to look at in front of us. This is the most surprising comment that comes up to students that are incredibly sophisticated technologically. They're so facile with the tools, and if you say, "Well this is great, but it's also not great." They're like, "What do you mean?" They're thinking on this track and not necessarily on another one. And yeah, that's something to be navigated.

Interviewer: What do you think about shared authorship where they can take a script from someone else, in a different country even? And some students build on that script, so it's like a shared authorship. Some just take it without crediting the source. But also a lot of teamwork or collaborative work is shared. What do you

think about that concept?

Thom Faulders: I almost prefer to ask that to the students because it's their moment during their education. As a professor, I don't necessarily have any issues with this shared authorship as long as we're just making sure that everybody's kind of getting something out of this. I'm not very interested in rules just because of rules, but we just want to make sure that there's kind of a synthesis of various minds involved instead of someone that just takes over, I suppose. But they are students, and so if there are scripts that are available and out there, I don't necessarily have a problem with it. Obviously, if we dig deeper and they're trying to present it as original research and they're not bringing up the fact that this is something that's floating out there, then there can be misrepresentation. But that can be the same with anything else that they do. So I think it's just simply important to note the sources if in fact it comes up in point of discussion. But you have to remind students of course that. And so many of them want to do the opposite right? They want to just start out re-inventing the wheel.

And first, it's really incredibly helpful – in fact, it's rather sophisticated to learn what others have done, history, to learn the craft, tools, and to take a little bit of time to build a kind of a foundation; the payoff is much better. And so if we can understand some of this, kind of, shared tools as similarly as we would when they're doing analyses of case study buildings – that's also worked on by others – but they're learning how things that were successful. They're unpacking them. And if we can, I suppose, have a mentality – and especially as this kind of world starts to build – of, it's called the history of – I don't know, let's invent something. Operational history, right? Basically tools by others. That can actually lend itself to pretty interesting kind of analyses, I think, in case studies.

Interviewer: **Because open source and everything is carried on the web, the age of information, it becomes hard to track what script is there and what's not.**

Thom Faulders: No. But it's open source then it is put out there. Someone has decided it's open source, and therefore, arguably, it's fair game. And I know people that have put stuff out there to share, and then they start to see a little bit later that what they put out there to share was, in fact, shared and used by others. And then they're like, "Wow! That's something I wrote, and there it is out there." And it's a funny surprise, but in fact one did put it out there. So, you know, [it] seems fair.

Interviewer: On social responsibility, do you think that digital technology changes or affects the way that your school deals with social responsibility of architects? How so?

Thom Faulders: . . . In recent times, we're very aware of what's going on in any corner of the world. And so if you want to talk about social responsibility, it's not only in our own community or neighborhood that we have the possibility to intimately think about and maybe to speculate upon, but it can be a much wider condition. So, sure, that kind of network mentality can at least open that up to us. But I think if we really want to talk about social responsibility, it's going to come back to what's driving the individual. And the discourse is set by a number of individuals. Are they taking on these issues or not?

Interviewer: If we looked at the Russian and German constructivists, they took some of the social problems that they had at the time and they used the technology that they had at the time to produce something to solve these problems, their social problem. Do you see that happening now? Are we involved in social problems that we're facing? Are we trying to change the social condition that we're in? Are we trying to improve it? Do we teach that?

Thom Faulders: You know, it doesn't matter who it was, but we had a very well-known architect come in who had been in practice many years, and their work probably was and is mostly informed by this first round of digital capabilities, of complex form-making, complex curvatures, and really kind of amazing architectural – let's just call them artifacts or constructs. And you realize how difficult just to make some of this happen is, and it's kinda of what is. And it remains an impressive body of work. And I was noticing, taking the pulse of the students, the following generation or half generation, or whatever the case may be, that they found it not so interesting because they've inherited this, and it felt like form for form's sake. And I think at least here the students are hungry to, in many ways, take on social problems – and whether it's making park-like settings everywhere and green roofs all over everything they're doing, or whether it's looking at informal urban inserts – I think it's very much in the air right now. And I find the students nicely – there is a politic there. I have always felt this: I think sustainability is an overused word today. But I think for students there is a real politic, "We've got to use less. We need to do better. Let's not do what previous generations did," and so on and so forth.

So, I don't see this group as quite as interested generally in using incredible tools and just making hot shit form and being satisfied with that. They're trying to make the world a little bit better through trying to address these other issues. We're very much a decentralized, globalized, architectural community when you look at all the online blogs or magazines and everything else, and so we're not quite as focused probably as constructivists. And we're telling [everyone], "Look, here's our message." . . . I think there are some intangible aspects of just making something that's uplifting and amazing that I think can work wonders. I don't think we're just here to solve problems only, and if we look at music, literature, film, or anything else, we're reminded of that constantly.

Interviewer: What percentage of your design faculty use and/or require the use of advanced digital technologies (parametric modeling, simulation software, digital fabrication, etc.) within their design studios?

Thom Faulders: . . . I would say that it occurs throughout, and whether they're intro students – we're introducing them to the various softwares – to focused studios that are really looking at digital fabrication, to their advanced tools classes where they're looking at programming and whatnot. So I see it is everywhere.

Interviewer: So there is no percentage of faculty that use advanced digital technology?

Thom Faulders: Well, whether they're using it or the students are using it, I'm not sure how important it is to separate that. But I think the students almost have accepted this. For some faculty, they're heavily invested in this. The students, at some point, start to have way more capabilities than the faculty do because they're in it doing it every single day. And most faculty, I think, are – whether they're older faculty – they're running offices, and have their hands in a lot of different things, and so they're not behind a computer all day. Or if they're students that have just been introduced to some kind of new program that they're interested in, trying to work out, I think that we have been in this interesting period. And you hear this from the faculty and you hear it from all the students that, "Wow! Look what these young guys are doing," or, "The first years are doing stuff that now fifth years say, 'we couldn't do this back then or even today,'" because there is this changing landscape.

And we see this in architecture offices where we have a group of people with – it's not just the principal that has all of the tools that he or she is the best at, and then there's a pyramid from there, like the overdrafts person, because he or she has specifically been doing it the most. And now we come into an office, and we've got this script person that is just facile; we have the renderer that has faculty at this. And we have the CAD monkeys, and they might overlap or not. And I think as the tools become more vast, I think within what it is that we do, there's overlaps. But then these specialties start to come up, and I find this in studios as well, and I think this happens with the various professors. We do have many full-time and adjunct faculty that are highly invested in this – and again, I don't know what percentage it is – but are absolutely engaged in what you're calling advanced, I guess, tools and able to teach it, but keeping up. And I think there's a difference of being able to teach the tools versus having kind of a facility with guiding those tools.

Interviewer: **Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?**

Thom Faulders: Well, if I understand the question, I mean, we wish we could offer them more. We wish we had more digital fabrication tools but – you know, it reminds me of a sculpture professor. I remember her saying once that, when I was in school, it doesn't matter how many tools you have; you still have to use your mind and your talents. And so, there's this kind of space race with all of the universities today to have as much as possible and incredible. And it does have, I think, certain ramifications. You look at what the output is. But it's important that we're also breeding thinkers and not just technicians and tool users given an amazing tool and an amazing software and just give that to somebody the first time around, giving them a few connections. And the most incredible outcomes can take place that we can all be blown away by. But, in the larger picture, was that just kind of a step-by-step 'do this and then do that,' or is there actually some real facility in trying to think beyond the tools? And it's both. It's both. So, not one or the other.

Interviewer: **Well, how can we do that, Professor? How can we think beyond the tools? How can we prepare the students to think, in a way, that whatever tool is in hand and whatever technology they have at the time, they can adopt easily. How can we prepare that future architect or designer?**

Thom Faulders: I suppose it's understanding maybe the school isn't the place to be that critical. I think whenever we go to school, we are product of the era, right? And maybe it's understanding simply the lineage, the longevity, and the connectivity to the work that's being done. So, if there's a lot of output that's being done, at some point, it seems important to ask, "Well, what are the ramifications of this?" Finally, it's done by others in this field that [are] creating architecture using the same processes. There's been a backlash in this kind of architecture, form making, amongst some. And they're starting to understand why you can make all this stuff. Is that enough? What can be critiqued about it? So I think it's a good question. I don't, quite frankly, really have a good answer for it. It's something to ponder on.

Again, I'll go back to a little bit of what I have been saying today. I don't think it's only about the tool, and I see this on juries. We'll be running classes; we'll have maybe one or two students that are incredibly facile with the tools. And they make these kick ass drawings, and models, and all this stuff. And as professors seeing this happen over 14 or 15 weeks, you're kind of excited and you're like, "Wow! This is amazing kind of productive moment." And then, you'll have guest critics come in, right? They've never seen a work before. We bring in out-of-town critics, like we always do, like in other unit schools, and they might gravitate towards the clunkier project because the ideas might be a bit more provocative, less polished, maybe be more hitting on some key questions, unexpected moments.

And so, facility isn't the only thing that I think is provocative, and I guess this is maybe what I am trying to understand as I teach and understand as we're going through these questions. I think meaning lies beyond facility. And yet when we talk about technology, we're talking about capability and the facility and the use of these tools. And sometimes it's the thing that comes up that just was an aberration to any of what we are supposed to be doing or even using. Then that can just really be a moment of brilliance, and there you have it, right? That's the art I'm talking about; that's the beauty of doing this thing of architecture.

Interviewer: Do pressures from the profession affect the way your school has adopted or implemented advanced technologies in the design studio curriculum?

Thom Faulders: . . . Students today, and we do a good job of it, expect to be well trained. They, more than ever today, are feeling economic pressures. And I, as an educator, believe in the broader purpose of being educated, not simply as a practitioner but as a broader thinker; that you'll have for the rest of your life. That's powerful stuff.

But I do find myself wanting to contextualize, more so today than I might have been in the past, why spending time thinking about some of these things could have real world ramifications or connections. But it's not just esoteric exploration or speculation because we're in the walls of an institution or an academic environment. There might not be a one-to-one set of relationships or connections, but we can draw them. And I do find myself more compelled to explore that territory with the students – why it might be meaningful to spend time listening to this stuff . . . And even, if we're in the institution or we're taking this kind of seminar type of stuff, it seems meaningful to make those relationships to that field out there.

Interviewer: **Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?**

Thom Faulders: I would say we're almost too ethical. In the past it was called political correctness; it might be called trying to do everything. We're trying to be masters of everything, that we're sustainable, we're social, we're technologically sophisticated, we're form makers. It starts to just get incredibly bland and boring to me. And the more tools we have, the more capabilities we have. The more connected we are, the more kind of insight and awareness we have. And I think, at some point, I think we need to shut out some of this stuff and turn up the volume on some aspects of our exploration. I think we're trying to do it all, and many would disagree with me, but I think through kind of focused expertise, I think we can lead and inspire others to do what they do well.

And ethics is a part of that. These poor students, if they have a building site, they have to contend with the fact that they might destroy the ground, this piece of earth that exists in a pure state so that they can speculate by putting a piece of architecture there, right? Because everything that we are discussing today is that we're chopping up the land and we're using resources and so on and so forth. And guess what? As others have said, putting architecture out there is a violent act. But it can be incredibly meaningful as well, important, and it's easy to forget that we are social that way and we're building hopefully a good culture. And so this, I mean, not only that they're trying to build a building, but they have to contend with the fact that they're going to use resources, which is ethical, right?

Interviewer: Some may say that with technology we're able to gain or take back territories that have been taken away from us.

Thom Faulders: . . . In the real world outside of school, in many ways we do less because of the kind of sophistication of building today. And I was just describing that simple house with the Savant System, the iPad. I could not even keep up with the discussions. This is a single-family house, mind you. The discussions between the engineers, various engineers, media and lightning consultants has become so wonderfully sophisticated. It's energy efficient; it's smart, right? It's networked. I have no complaint at all. That's not the point why I bring this up. But this goes way beyond what I, as an architect with my broad knowledge, would be able to do, to do layouts and understand all aspects and details of the loading and the lightning and everything else, which not too long ago we would have easily done; we would have calculated all the structure and everything else. And yes, we could do that, and many I'm sure do.

Most of the field, I think, is more specialized because of more possibilities and more capabilities. And again, not a critique, just an observation – part of making smarter energy systems is to bring in energy engineers. We're not just tapping into the power system only, but we're loading this up with using sun and kind of switch off systems that are interconnected and so on and so forth. And at some point, that really is an engineering specialty, and it's wonderful to work with these folks. I actually quite like how sophisticated some of these things are. So, yes, it makes us nervous because of the scale of the projects that I'm often doing in my practice. The drawings that we do go straight to digital fabrication, so are we empowered? Sure. But it's really freaking nerve-wracking because we have the liability; if our drawings are wrong, the final output is wrong. But we're not the contractors. So, if a contractor misinterprets our representational drawings, our information, that's on him or her. But if the contractor or whoever is building or fabricating something, if they take our drawings and we say, "They're ready to go. Print them at full scale," and if there's a glitch there, of course that's on us. And so, yes we're empowered, and we're more liable.

Interviewer: **What do you think are the most pressing questions and issues regarding the design studio environment?**

Thom Faulders: The most pressing questions I suppose are to keep it open-minded and moving forward. And just because we practiced one way in the past doesn't mean it needs to happen this way in the future. Like, really to feel free to break with tradition, with practice – that's not to be ignorant of it at all, and that's the caveat in here; knowledge is empowerment, but as things and as practices can happen in ways that we can't even understand today, that's exciting material. And that's what I hope to leave my students with, to not only understand how things might be working today and certainly in the past, but it will probably be very different in the future and [with] most buildings. I'm actually more invested in the outcome of this, not the process.

I'm not a technologist. I'm not incredibly facile with tools, but I think a lot about making the environment as intelligent and as smart, whatever that might mean, as is possible, which means asking more and more of our environment and our buildings and how we use tools and other ways of understanding architecture and their full processes. That is interesting. But I like to think about what it is that we all come to the table to do, which is to think about the final outcome.

Now, it's funny I would say that because in many ways I'm a product of this late '80s era of paper architecture, and I run a pretty selective practice. And I don't run a meat and potatoes kind of practice where we're just putting up buildings. And probably, I don't know, I haven't counted, but I might have more exhibition work than practice work or whatever. So I'm obviously involved with architecture as a discourse. But still, for me, it doesn't have to be built to be real, to be a part of what it is we call architecture in the discourse. But nevertheless, I like to take my students through to really think about what might this mean if this was to be realized. If this is to be built, if this is to exist in our city, if we are to exchange with it phenomenolgically, how can we understand that?

Interviewer: **Is there an issue that I have not broached that you believe is imperative to understanding the implications of these technologies and their relationship to architectural education?**

Thom Faulders: No, I think we've covered a lot of good ground, a great set of questions, and I think since we are talking about pedagogy and school, that is one place where we can both push technology but also ask questions of it. And that can be very difficult to do at the same time. But it seems like if we are involved with advanced thinking and advanced education, critique is part of this. And I think we want to teach our students this as well, at least to be aware of that.

There was a test given to grade school kids – I don't know, I'll say fourth grade – some years ago, just this calculator, to give highly erroneous answers to fairly straightforward mathematical problems like multiplication problems. What's 36 times 72 or something? Just do it out on paper. Or even smaller integrals where one could at least use a logic that is probably not going to come up with 1,000,275, alright. And yet these kids, because it was a calculator, because it was a piece of technology, because they've been born into this, they wrote down the answer. Well, you know, 36 times 72 is a million whatever. Okay. And there's a blind faith in not being able to be critical of a solution.

Now we're not talking about just simple math or a calculator; we're talking about complex technologies in many ways. But, can we have that distance? Not to be dubious, that's so boring. Not to be pessimistic, that's uninteresting. But just simply to be able to question relevance so that we can use things in a more efficient, a more interesting way . . .

The last thing I'll say that – my students, since we were building these large things after they were drawing them, the surprises that happen, right, the spatial complexities. "Wow! I didn't know we would grab light this way, or the structural conundrums." "Wow! It seemed to work so efficiently on a model, and I'm now building it, digital model." You know these kind of simultaneities and these things that allowed them to get some kind of critical insight into the smoothness of a model, digital model, maybe is kind of a space that I'm trying to understand.

Interviewer: Well, thank you so much, Professor, for your time.

Thom Faulders: Thank you! Great set of questions and nice lot of conversation there. And I guess, keep me posted from time to time whatever happens, but good luck with the project.

Interviewer: Thanks.

18) William MacDonald

Interviewer: Regarding the influence of technology in contemporary architectural education: Do the models/paradigms associated with digital technology shape or inform pedagogy at Pratt Institute?

William MacDonald: That's a big topic. Both in the way it's being taught and actually what's being taught? . . .

Interviewer: Which models/paradigms of digital technology are informing design pedagogy at your school, Pratt Institute?

William MacDonald: Informing it? It's tough to say that there are models that are existing, frankly. Both Sulan and I come from Columbia University, obviously. So we were there during Bernard Tschumi's time as dean there, and it was a terrific moment . . . I would say that there's a lot of people that were interested in terms of design and the way in which it was taught and the influence of the digital and informational realm. So ourselves, Jesse Reiser, Nanako Umemoto – Nanako, in fact, teaches with us now. Thomas Leeser also teaches with us at Pratt now. Manuel De Landa, who teaches theory – they're with us now. So there's Greg Lynn who's teaching at the Angewandte in Vienna now. All of them sort of have left on me at this point, but it was an interesting moment there in the sense that the digital design was considered generative design.

And because of that model, it wasn't just looked at representationally, but actually almost devising relationships between generative aspects, representational aspects in terms of the renderings, but also the way in which it's built and, ultimately, the way in which it's fabricated. So I would say that if there's one thing, let's say, a desire would be to make a really kind of seamless relationship between concept, design development, production, manufacture, and assembly. I think that probably still has maintained, I would say, the way in which we approach it today.

Interviewer: Some schools, Professor, they adopt a specific technological paradigm, for example, information theory, network theory, or general systems theory, where they emphasize the unit to create the whole. That's how they derive their design studios. Is it a mix of different paradigms, or is there a specific paradigm that you are following?

William MacDonald: . . . It's much more so the individual research of the faculty member because they're so ingrained in a digital, almost proprietary work in and of themselves that they have very specific concentrations, very specific interests . . . They, broad-stroked, would relate much more to a unit-system relationship than necessarily part to whole, which would also suggest more representational work rather than more generative and relational in construct, so that the unit to system is a more direct, almost intimate relationship, which is derived from relational construct rather than one that is necessarily composed representationally. It’s not to say that representation doesn’t play a large role in the digital.

Interviewer: Then there is a freedom for the professor to pick the paradigm that he or she wants to teach through? There’s no specific philosophy that all the professors have to follow?

William MacDonald: We encourage experimentation. I would say many, if not all, of our faculty are extraordinarily adept in digital processes and digital techniques . . . And the idea is really to develop differences in not only the attitude towards the generation of production, but also ultimately the yield of architectural work. So, we’re really looking for the students to key into themes that the faculty provide, then really provide difference and differentiation in terms of the trajectory of the digital procedures and projects. There’s a certain collective, obviously, in terms of what is capable with particular scripting techniques and stuff, but ultimately, the idea’s to see the potential and range of work . . . It’s much more broadening. But the broadening is specific in terms of developing strands or trajectories of the ways in which the work really can be valued in and of itself, but also in relationship to contemporary discourse. And in that sense, I think we tried to really take the studios as well as the students’ work [as] a way of contributing to progressing that discourse, hopefully, your profession forward.

Interviewer: How are different paradigms integrated into the curriculum?

William MacDonald: Well that’s interesting. The way that we start off, almost 50% of our students have architecture background and 50% are non-background. So, it’s a very interesting dynamic which we like to have. There are three different programs which I chair: Master of Architecture, which is the first professional degree; Master of Science Architecture, which is the post-professional degree in architecture; and another post-professional is Master of Science in Architecture and Urban Design. So for Master of Architecture, there’s a kind of 50-50 break between the architecture background, non-background. We approach the first project in studios that’s been related to abstraction and conception, and [we] emphasize with background who may have already been accustomed to certain ways of thinking about architecture or approaching it. In that way [we] really allow the ones with background to question what they have done in the past to what they might be doing in their careers here as a way of also building up technique-based systems for the concept as related to technique for the people coming from a non-architecture background.

So that sort of leveling of the playing field is very important for us because we then emphasize what we’ve hoped is a sort of [a] combination of design intelligence and talent towards particular idea-based projects, which really originate out of first material-based constructs, but then moving that towards more and more digital and the relationship to material practices as related to digital all the way through the semester and then ultimately producing an architectural project at the end of it, which is urban-related but architecture defined, so very much a kind of small scale, but infrastructurally related stuff

– something to do with subway, something to do with buses that they plug in to larger urban systems. From there, they move into even more architecturally refined projects, which have much more to do with site. Ultimately, much more to do with programs; it's, in a way, evolving the digital aspect with a concept-driven work. We hold separate computer media classes, obviously, which are integrated into the studios from the day they walk in to the studios.

So, it's not that they just run parallel courses, but that we have a studio instructor and then we have a digital instructor who works with that studio instructor in the studios for the entire three-year course. By the time, of course, you go through three years of that, which is six semesters, you not only have required computer media studios, but you also have what the implications of that work, of computation is relative to the design work. And they are working with you simultaneously on the design projects. We found that to be the best method. Really, of course the primary goal – there's obviously the design work, but in order to reach the levels which we reach in terms of the satisfaction of the work, it really becomes necessary to continually develop and invent, frankly, techniques towards the production of the work.

Interviewer: Why do you have two instructors?

William MacDonald: The studio instructors are obviously very adept at the way they approach architecture and design in general. But, we feel that there's a level of . . . tutoring work that needs to bridge between the computational work done and quad computation and then the quad studio work. At this point, there is a very blurred line between the two by the fact that we teach them together, basically. And the attitude there is that you can be as inventive in terms of the way you approach scripting or computation as you can with the production of architecture. And the two necessarily go hand-in-hand. So there are, in essence, two strains of concentration which are intertwined, are almost ether-like in a certain way, so that you really have to identify not just the way you're approaching architecture but actually the methodologies through which architecture is being yielded to you through the investigation of computation as related to architectural yield.

Interviewer: So one is an expert in adopting digital technology; the other instructor is more with design theory?

William MacDonald: Your topic is interesting as you're introducing it to me as the Industrial Revolution and Information Age . . . The Bauhaus is interesting in the sense that they also had a dual track. They had sort of a craft material professor along with a design professor. So they both involved themselves in terms of theory. I will tell you, I would say so do we. But they probably have a more refined relationship to issues relative to design and material practice. For us, it would be design and material practice relative to generative computer graphics systems but more in terms of design intelligence, which links the two together. It's less of a separation [than] it was at Bauhaus where you had an expert in this and an expert in that. You put the in a studio, and then they provide a kind of combination. Rather than that, there's already a very fluid relationship between digital design practices that come from the design wing and computational experimentation, which comes from the computer wing.

So in our situation, the design faculty have an expert knowledge already of computation. But in terms of establishing direction and so forth, they may take a little bit of a lead there. But our computation faculty is also very sophisticated in working with these design attitudes, and they're very much aware of the goals. It's really a kind of collaboration . . . What's at stake is the work in the studio – and everyone is contributing to that architectural project from slightly different vantage points – but each one is expertly knowledgeable of the other one's concentration. I think the other issue there, frankly, is just timing where you have only a certain amount of time in the studio. We want to value it as best we can, you know, the trajectory of the studio and work in hand in theming the studios. The other is, actually, it's the methodology through which that's accomplished. And the two are involved almost inextricably in that system.

Interviewer: What about the abstract focus? Is it hand drawings of geometrical models?

William MacDonald: I love that you asked that question. I think a hand drawing is part of thinking for architects. I mean, in most sense, it's kind of like breathing. If I'm speaking, I'm usually drawing, and I'm waving around my hands because I don't have a pen. But that's one way in which we are visually trained ultimately, and so, any visual tool, whether that be the pencil or the computer – the computer is, I think, more than a tool. I think there's a kind of logic involved with it. It's more of a partnering in that sense. And it's a third collaborator in the construct that I just mentioned between the design faculty and the computational faculty. Of course, the design faculty are certainly digitally adapted. The computational faculty, certainly, have design sensibility. And the digital processes we like to think as maybe a third partner in that approach to both conceptual practice as well as material practice. And at this point, it's become so evolved, it's not only integral but intrinsic to the work that's produced.

Interviewer: What kind of assignment do you give in the abstract class?

William MacDonald: One of the topics, for example, was Chase Manhattan Plaza and the ways in which Chase Manhattan Plaza could be thought of. We could do subways underneath. It's one-story here, but it's actually five stories below-ground subways. We're on artificial ground at the moment even though it looks like natural ground. So taking a look at the ways in which the plaza itself, public life, can be augmented through new relationships between public realm and the way in which the private and public realm is understood to be no longer opposite, but in fact a kind of fantastically gradated realm in which work and leisure as well as infrastructure are no longer able to be delineated in such stark contrast. So, the material systems of that would be to take a look at the way in which, for example, material networks are brought to bear in their ability to adjust relative to differentiation rather than stark difference. So the materials are addressed also, almost deploying digital logic within material practice and vice versa, deploying material practice within the digital realm.

Interviewer: I see, so it is nothing like the basic course at the Bauhaus.

William MacDonald: For us, it's a different abstraction . . . You'll see there's a lot of meshes, for example, screen metal meshes or burlap or material, which has its own network value, which is – even foam, which starts to develop from unit configuration to systemic format. And of course, that builds into the argument of using the material with the logics of the digital and computational consideration. So, [it's] not so much understanding the material nature of the graining, for example, but in the nature of the material, its capabilities, what it's able to do, in terms of bending or shaping or holding the form or how it will be manipulated – but also to see the ways in which that material operates systemically towards those specific techniques. So, in that sense, it's somewhat analogically understanding the computational value and the material and logically understanding the material value in the computer as network.

Interviewer: What do you think are the positive and the negative implications in the use of these paradigms?

William MacDonald: Positives, I think. I hope it's self-evident within the work. We've had extraordinary success with the way in which we've been able to – I think we've only kind of scratched the surface, frankly, of the capabilities of literally generative scripts. Again, you're situated in an interesting time period because I would say the industrial revolution would really be focused on, not necessarily the systemic values of buildings in terms of a finite system. I think what's very interesting for us is the ability to take a look at open-ended systems just thought of incrementally, aggregatively, so that the icon of a museum for example, we're looking much more towards its ability to continually expand rather than developing additions onto museums. We would be much more looking at the ways in which a working, living display would actually start to re-qualify the condition of the museum as [a] system which will perhaps extend over time.

So . . . how do you design with time and in time rather than as projectively, rather than for time? . . . Actually developing a set of rule-based systems which would then be used through the course of time in terms of not only adding onto it as much as adding in value – and maybe even through its own alteration be re-examined through the systems that are continually evolving. It never really ends or begins, but can be re-valued through the way that we think of architecture and approach architecture not just as renovation. We hopefully think of it more as an altered state and the way in which that would provide new conditions for addressing differences in economy, differences in materials, differences in spatial configuration or program in general. The buildings that surround us now were one time primarily office buildings. Today, many of them, maybe approaching half of them, are residences. So, designing for any kind of specific function really is antithetical to the way in which we could be approaching design more atmospherically. What you're really looking for is the ability for evolution to occur rather than having such a close fit between program and space.

Interviewer: Do you think, because of the use of advanced technology, maybe we lost something compared to a traditional way of teaching architecture and design?

William MacDonald: I always have a bad reaction to this sense of loss. I think there's a nostalgic position to that. I don't think we lose anything. We gained a lot . . . I do think of it more as an evolutionary system where it's not so much about 'I had it at one time, and then I lost it somewhere else.' With hand drawing, there's always this somewhat manufactured fear of losing hand drawing. That I think is part of the nature of the way in which we think.

We're able to actually advance that through the use of in-time 3D models, which in the early '90s was a sort of revolution. Now, it's taken for granted that middle school students are actually using these models – they're what? Nine, ten years old – in the work that they do. And I think that that's simply culture advancing. And I don't think that looking back nostalgically to the times when we were doing ink on parchment and washes is necessarily something to harken back to as much as a necessary and desirable step towards new and different techniques, which occasionally we look back to in terms of developing new techniques. I don't think that it's – nostalgia is an interesting term. I think, officially, it's a desire for a better time. And if it's thought of in that way, I guess I would have to agree with it. It's when it takes a historical perspective only that I think it becomes limited.

Interviewer: Some may say that we lost the sense of hands, the sense of scale. How do you believe that technological models shaped the critical thinking, the way we teach architecture and design?

William MacDonald: That's a very important point. I think we also have a tremendous theory of faculty luckily, and Manuel De Landa is here, Catherine Ingraham. We have a plethora of very talented young historians and theoreticians. And they are integral to the way in which we approach theory. I'd like to think the design faculty, as well as the computation faculty, as well as our technology faculty, frankly, come from very critical perspectives, and again, I don't think there is a loss of criticality once you sit down at the computer. I think that's a level of design intelligence that has to be brought to the work. It's really the way in which we were able to develop a progressive environment to challenge certain ideas. I think that critical perspective really comes from, in my opinion, trying to progress forward. So, you have to maintain a critical position even on what was done yesterday. And you have to put it to the test. You have to develop it.

But there is an evaluative condition, and there is an assessment as to whether or not it's considered valuable, not just in terms of architectural yield, but almost in a critically cultural level so that you are thinking about it politically, economically, materially, certainly technologically. And in that sense, that hasn't changed. I don't think that technological breakthrough necessarily weakens critical vantage point. In fact, I think it might intensify it because of its repositioning of cultural context relative to another way in which we work, the way in which we live, the way in which we perform. I don't mean it as just in an augmented reality, but I think there is a sort of augmented sense of self relative to cultural context which is undeniable – I think it's better said inevitable.

It was always that way. I think the technological breakthroughs and the Industrial Revolution, the concrete, this material, the way in which we built influenced the way in which we thought about architecture. To a large extent, that's always been the way, will always be the way, and if you're not doing architecture as a cultural act, then you've really limited the focus – abstraction for the sake of abstraction rather than for it to be fully participating with environmental concerns on a broad scale, whether that be ecological aspects or organizational.

Interviewer: Do you provide classes that foster – theory classes related to the digital age or information?

William MacDonald: Yes. I would say that that's true. I think that if you're doing theory today, then the people that I've mentioned, for example, are very engaged in what's happening in contemporary architecture. I always threaten to run history courses backwards starting in 1750 working till today. We actually take a look at the contemporary culture and see what would be the seeds of where we've come from and why we are where we are today. We have understanding, maybe, of that evolutionary process, so rather than coming from an origination point to today in terms of category, much more looking at history and theory organically and almost in a reverse feedback mode.

Interviewer: Do you believe this relationship will evolve over the next 10 to 15 years, how so?

William MacDonald: . . . What's great about architecture in general is that it continually revalues itself relative to the cultural context in which it is in. Again, that is a relational construct. So, whether you are thinking about site ideas, or program ideas, or material ideas, production ideas, assembly ideas, computational ideas, you're always valuing it relative to those that you're providing, or projecting architecture for . . .

It's interesting; in copyright law, there are three paradigms. One is improvement, innovation, and invention. We operate in different ways in all three of those depending upon our intent, that we are meant to improve situations by how we intervene in them, where we are certainly meant to innovate. We are also certainly meant to invent, which is perhaps the more risky of all of the three in the sense that failure is necessary in order for advancement to occur. They are also all dependent upon each other. Almost again, a co-dependency where you could not have innovation without invention; you could not have innovation without improvement. So, in a certain way, if we'd almost establish that as our method of operation, then our goals, in terms of not just reacting to cultures, can only be afforded through a fully participant engagement of all of those three.

Interviewer: Which technologies or technological paradigms do you think will be most influential in the coming years? What are the major/key issues that you see arising?

William MacDonald: Well, Sulan and myself are interested in network theory. I don't know if I would look at it as a paradigm, though. I think it may be a paradigm shift, you could say. Again, I've got to look at it in an evolutionary model, but I could never think of assimilation without thinking of network theory, strangely enough . . . One of the great talents of architects is their ability to . . . be interested in different bodies of knowledge and expertise, but to actually engage in them in the manner in which they are able to be assimilated towards a goal. And network theory, not so dissimilar in that sense. It's an opening, not a closing of methods through which ideas are produced.

And so, you see that with designing at large. There's an incredible collaborative, almost influential structure that we arrive to as designers or architects. We are immediately put in situations where we are trying to influence a building to be built whether that be with clients, or economies, or construction teams, or engineers, and so forth. By the nature in which we work, we locate ourselves within an influence structure. That's true in term of the production of the work, but that's true just culturally. It's a great strength, actually, and always was. Architects, in particular, maybe – but designers in general have always looked to external sources, external conditions which are influencing not only them but the way in which we approach issues, or actually provide polemics in which we mean to address concerns which we see culturally. Or not even concerns projectively. That comes back to what I would call a design intelligence. That there is an interest, an awareness of what's happening on the forefront of solar technology and great storage systems that are now being defined at MIT. And what influence would that work have on the way in which we would produce architecture today?

The idea of buildings operating completely off grid, not just sustainable according to some design guideline or rulebook, but actually approached inventively and possibly looking at it on an urban scale rather than simply on building to building being self-sufficient, but creating of neighborhoods where the buildings would actually provide energy not just for themselves but actually for the neighborhood to extract pollution from the air to these great finds in science now.

We just held a conference recently under the rubric of NEAR, which is the Network for Emerging Architectural Research, which linked in leading scientists around the world to architects. We put them in the same conference and tried to derive a kind of nexus where science, technology, architecture, design really could come together to progress all fronts. And that level of assimilative thinking and method is something which is very natural to us, not necessarily in the scientific world, interestingly enough. It's much more focused on specific research, but the experience was terrific for them in terms of seeing a different way in which research is shared, I guess. They're used to sharing research in very particular formats, but here it was much more interactive and I would hope more accessible because of that.

Interviewer: On the influence of technology/technological paradigms on the social formations and culture of architecture schools: How are digital technologies and their associated paradigms changing the social structures/culture of the architectural design studio? Of the school?

William MacDonald: It's difficult for me to break out social concerns from architectural ones, I guess. That is one and the same thing certainly. So, on every level, the way that people work is radically transformed because of computation, because of network theory, because I can work in Colorado on a project that I'm doing in Dubai. That's certainly an architectural project. It could be I'm working in the Skype conference that I just came out of. Some are in the States; some are in Europe. Some are in Istanbul; others are in Copenhagen, actually. So, I think that is the way in which many people work currently and not just us.

Interviewer: How about in the design studio at the school?

William MacDonald: At the school we'll set up juries, for example, between the University of Pennsylvania, SCI-Arc in California, MIT in Cambridge, and we did this actually – the differences and similarities in terms of digital technique. So, the minute that that happens, you're talking about not just the way in which we're working in architecture, but actually the way in which society develops as well. I mean, it's not an isolated condition. We're working within the milieu of how we work but how others work as well. So, Ben Fried did this great little – see? – an enemy diagram which tracks the kind of waxing and waning of networks along the internet in terms of interest and relationship and linkages, dependencies, so forth. It was kind of fascinating as both a social project as well as computational one. And the advent of social media, for example, the differences in economic levels of society and the ways in which those are communicating—

We are doing a project now, actually, Sulan is working at the moment, as a matter of fact, for the Istanbul design which I mentioned. And we're using the most advanced computational systems relative to complex adaptable systems and the ways in which scripting is really being pushed way where you really see the outer envelope. But then in the production of it is actually going to be a handwork done by disadvantaged women from areas of Anatolia in Turkey that will be on exhibit. We will be working on the projects in the museum. So that is why I had a difficult time separating out socio-economic issues from designer or architecture work in the sense that, both in terms of the provisioning of what architecture can bring to design and the inhabitants of the environment, but also in terms of even cutting-edge work and the way in which that could be thought of in terms of socio-economics. They are affiliated with a non-profit institution, and that non-profit institution is seeking ways into expanding.

Ultimately, we were trying to seek the ways in which even the museum audience in that project can intervene as another opening to the way in which that project results. We're sort of assimilating these different realms, different contexts, in order to benefit all of them and to find new techniques. There are many situations in which that happens, also fashion, [such as] Donna Karan and the work she is doing in Haiti and in with earthquake situations and the ways it involves design as much as it involves society. And she is actually involving architects in that project as well. There are many others. I think it's a kind of heightened consciousness relative to the capabilities of design and the way in which we can fully contribute . . .

Interviewer: What social modes/organizations (team-based design, hierarchical organizations, agile organizations, etc.) are enabled or disabled by this integration of these technologies?

William MacDonald: We feel that there is a very intimate relationship between the instructors and the students and the students and the students. One-third of what you'll understand here is really from the studios and the courses and the faculty and the other third is really the environment that we provide for you in terms of progressive design environment and, hopefully, one which is socially and ecologically attuned if not advanced. But the other third comes from interaction with your peers and your generation. They will always be with you. And the studio is a fabulous environment in which to contribute to each other. Critically, it's a tremendous luxury, which is somewhat unofficially constructed in schools, but ultimately, that generational contribution exists always through the people I was in school with. They may have been in different schools, but we certainly knew about each other. We are very often on conferences with each other and exhibitions together. We are often in each other's offices critiquing each other's work.

That's something that has to be very valued and nurtured, I would say. That doesn't happen just naturally. I think it's very important for that level of sharing to be constructively critical . . . Not just a matter of being critical, it's actually criticality with the idea that we're meant to advance our culture, as well as culture at large together.I think it has to be constructively competitive as well. I don't want it to sound like it's not competitive; certainly it is . . .

Interviewer: How about the role of technology? Do you think it's changed the way we organize the studio compared to old schools, traditional schools?

William MacDonald: Certainly. Even the way we set up the curriculum today, we're forced to put in different categories like design, history/theory, and computation and technology, which is different than computation. It's very difficult to have these category boundaries, obviously . . . But ultimately, the work is much more integrated and organic than that. So we spend most of our time crossing those boundaries in terms of our own little trans-disciplines, but hopefully, outside of our discipline as well. And I think theory plays a large role in that.

There's an immediacy to the production of ideas, which is very enticing for us to be involved [in], and even though the production of buildings is a much longer time frame, the possibility of those being zoomed in and zoomed out continually is a rather privileged place to be. We may approach that aspect of education different structurally in a sense that the lines of division are not necessarily meant to divide but really to provide a guideline of concentration with the intention that there's a fuzzy – more than fuzzy, liquid border between them.

If you're really interested in advancing discourse in discussion, which is I think how we progress, it's the way in which we evaluate what we've done, which can only be done in debate, and to provide a forum through which you're really able to address concepts through the work. The most successful juries are always the ones which really see the projects as being so evolved that they can rise to the level of cultural critique, technological critique, theoretical critique, methodological critique rather than simply the project per se. That's where it becomes the most interesting for everyone involved. It's just not how good we are doing something, but more how have we contributed to that debate.

Interviewer: Do these technologies positively or negatively affect peer interaction/learning within the design studio?

William MacDonald: . . . The issue is really what's at stake in the studio as a project culturally and also architecturally. And then, how do you bring different strains of expertise with the same goals and objectives in mind to that project and marshal them or influence them to the betterment of that situation. There has to be a willingness to participate in that stake. To a large extent and from our perspective, we have seen not only a wanting, but really a desire to do that. If the project that you're proposing is significant enough, then, in terms of its progressive intent, it behooves everybody to work towards that. It's almost an obligation more than a desire, but it's a pleasurable obligation. It's what you will take out of that process as well for your individual work and also for the work at hand. Design culture in general has that great luxury.

Interviewer: What kind of organizations do you have in your design studio? Is it like a team-based organization, agile organization, individualistic organization?

William MacDonald: All of the above. For example, [in] thesis work, we have individual students working with individual faculty members. In our comprehensive architectural projects studio, we have design faculty, digital instructors working in the studios directly with landscape architects, structural engineers, mechanical, electrical, plumbing engineers, acoustical people, lighting people, environmental experts, where it's really as comprehensive an architecture project that you could make, which is design-driven. But all of those projects [are] either worked in teams of students, either two or three, and they produce an entire set of what will be considered contract documents. Every structural element is calculated according to the quantifications. Every duct is sized; every window is specified. That level of refinement of project can only be accomplished through all of the experts which I just described. We even have material scientists talking about engineered materials rather than just off-the-rack materials.

So, it's something for students to be exposed to that level of collaboration because that's what the profession is today. Unless you have an extraordinarily small practice where you're in control of everything, which I don't know of one, you're really put in the position of developing what I call influence structure in order to develop new relationships, define new ways in which to contribute towards that project. Putting the students in that kind of model is . . . very valuable on a number of different levels. They gain a very particular confidence in having moved through that studio, not just dealing with this galaxy of opinions, but also each one of those projects is done in a radically different environment. So, one will be done in a desert, one will be done in a rainforest, one will be done in a temperate climate so that the different ways in which you design, build, understand the environment relative to your project changes dramatically on every one of those items, whether it be structure, program, cooling techniques, shading devices, siting. It's very different working in the desert than when you're working in the arctic, and the ability for students to share that with each other, is greatly confidence building. But it's also confidence building in a sense that you've seen a lot and you've been through a lot relative to going from design idea to the ability to build something.

[In] many seminars, for example, which are sponsored seminars by DuPont and Phillips, we take a look at the new materials that they're working on and ways in which they can be integrated into architectural projects. Hunter Douglas is a big Dutch shading company with Bentley Systems. Again, this is under the rubric of NEAR, which are really more funded research projects. And companies that have never worked with each other before or never had their materials exposed to each other before are brought together through directed architectural research and, I think, to the benefit of everyone. Look at the way in which that network also can be revalued or reconstituted based on some things that maybe they never considered before. You're always put in the position of not just looking. What kind of environment are you providing for the studios to be in in order for them to be able to really excel?

So you're doing it as an internal level relative to the studio, but also then on an external level relative to the participation of the school at large, the programs at large. And then another constituency which happens to be culture at large and participating in exhibitions, really working with schools outside of yourself in terms of testing where there are similarities, where they are differences – I think that's very important in the whole theory about self-similarity. And that's very interesting in order to find out evaluatively where everyone is and even where the project is and where differentiation can be sought, invoked, incited . . . You really have to be forward thinking about where you are and where everyone is in order to devise where you should be going and what might provide fruitful direction and where not, probably, where not is easier.

Interviewer: On teaching students to critically engage the use of technology in the design studio: Do you teach students to critically engage/question technology/technological paradigms within the design studio? How so?

William MacDonald: . . . There's readymade material off the shelf products and so forth. We work very closely with material libraries and material scientists in order to look at engineered materials. Materials are being invented at this point, and so it's very important for the architects to realize that they have something to say about that, both [as] consumers of those products but also to take a look at where properties, attributes of the materials could maybe redefine the ways in which they're approaching their use. And so it becomes very important not just to know what the craftsman is able to do with the material, but actually the material that is yet to be invented, what its capabilities might be, and ones that have just recently been engineered and that aren't [in] building, and how to get them used in building even just legally, but then that has a real value.

Carbon fiber one time was not a building material, but which is probably an old form at this point. So, it's titanium. So, even that's an agonistics model, right? So, chemical companies that are devising new ways in which chemical alloys are being developed for ecological or sustainable aspects as well. We always like to try to take a design attitude because we think that that is really where we are today, where we can contribute best. And a lot of times that's proving to be a very strong positioning exactly because of not just interest but awareness and capability to take what's newly discovered and have the interest and the wherewithal to apply it. So, again, technology is continual breakthroughs at this point and both in the computer software, materials, even, God forbid, building techniques and fabrication, robotics.

Interviewer: When I attend some of the juries and I saw students using scripting, using plug-in software, for example like Grasshopper, with its definition and wires – but I don't see them think critically.

William MacDonald: . . . One studio I ran recently had to deal with minimal services and the ability for minimal services to be self-structuring, for example, and able to be connected incrementally, aggregatively. Those were done actually through a number of softwares not just Grasshopper. I think if you're just using one software, you're going down a wrong road because then you don't really have an intent critically; you're sort of playing with that particular software. But the ideas of the ways in which the studios are framed hopefully by faculty as well as studios and how are you using scripting – Grasshopper is frankly a rudimentary visual scripting software [that] is not really all that sophisticated at this point.

It's important to not only have a design intent, a critical intent, but it's also very important to understand that you're devising a methodology through which to attain that intent . . . At a certain point, you have to devise a method of working towards goals and objectives rather than just, again, representationally or compositionally arriving at something. There can be an immediacy with the computer in terms of its ability to work in three dimensions in time, in volume, in space; that is deceiving to someone who's not very attuned to what it's capable of doing. But ultimately, it's about an idea of value structure. It's about devising a thesis and moving towards that with a particular method or testing method relative to that thesis and theoretical goal, which is the project itself – so the bigger idea of project and the why.

What's at stake really? Why is this significant and why are we trying to get there, and importantly, how are we getting there? . . . And that's a danger in the autonomous in a certain way. There's a value in working autonomously in terms of experimentation, but you're experimenting for something. There's a real value in pure science and the real value in the pure practice of architecture in a certain way, and there's also a value in recognizing the opportunity of pure science to become applied science.

. . . And in architecture, we continually move between those realms. If we don't, if we only answer societal problems, we only approach design in terms of problem solving rather than projectively, generatively deducing opportunity for an engagement with the practice of architecture, as I said earlier, as a cultural act rather than one which is purely technique-based or purely result-based. And I really think the computer technologies available today, material as well as building or manufacturing, really situates us in a great position to do that. And it's done in the way that we've gone about providing an environment for that discovery. As what I've said before, in terms of invention, in terms of improvement, in terms of innovation, it's very difficult to separate those three off from each other. And why would you want to? . . .

Interviewer: On social responsibility: Do you think that digital technology changes or affects the way that your school deals with the social responsibility of architects? How so?

William MacDonald: . . . But we've developed building systems with very complex adaptable systems that are able to look at buildings not just in terms of facades, but in fact more unit and incrementally based or relative to sun, wind, rain, rainwater systems, and so forth. I'd like to think that that would also be considered socially responsible. It's interesting; in the States socially responsible work hasn't evolved from politics enough. It should and hopefully it will. If you do housing competitions in Europe, you're out and you're doing social housing. If you're doing housing competitions here, you're doing high-end housing. The few social engendered projects were socio-political projects in terms of opportunity. But I think, in the schools, obviously that is something that we can push, and we do that.

There is a movement now in New York City to look at even smaller apartments. I think they call it mini apartments or something like that which kind of spans the gamut of high-end and really socially responsible work in the sense of affordability . . . I think in terms of socio-economic terms, there is obviously responsibility to engage on that in a whole series of levels. We're looking at the potential for some of our students to integrate into K through 12 classes, for example. What I think is a great lacking in American school systems [is] more design sensibility and how to bring that to a wider audience, actually. And you have to wait until graduate school to start to consider design issues . . .

Interviewer: Teaching them designs.

William MacDonald: Well, design relative to mathematics structure in each structure.

Let's say, it's nothing all that new. Mario Salvador, years ago, at Columbia started to install, not exactly the range of public schools; they're high schools mostly. He's an engineer, a very famous one, fantastic teacher. And what is the innate relationship between compression and tension? Even something that basic is revelatory for certain people. It's relationship to physics and mathematics and proportion and design are science, technology, and mathematics all wrapped into one. That kind of relational construct where it's not just about aesthetics, but is in fact the impactful relationship between aesthetics, science, mathematics, physics that is assimilative in instilling [an] ability to understand the relations of things.

Interviewer: How about teaching a class about mathematics and form creation, geometry? And then from mathematics take them to Grasshopper?

William MacDonald: . . . The project I was describing where we're starting with minimal surfaces is their mathematical, physical constructs. So you have to know geometry in order to make one.

Interviewer: And take it to the digital technology.

William MacDonald: That's right. And then biometrics, biomimicry. Yeah, so fluid dynamics. That's basically one trajectory within the program, so I'd say that you're really taking a look at of how minimal surfaces are in fact, self-structuring. So it's mathematics related to structure, aesthetics, multiplicity, ideas of iteration, your variation. You're trying to develop methods through which themes are attained critically, but you're also looking at the methods through which that process becomes critical also. So, you don't get into a situation of just whimsy with the computer . . .

I gave a lecture recently at the University of Illinois, which was titled "The Naturalization of the Artificial and the Artificialization of the Natural," and there's fantastic examples of how the computer actually mimics the brain ultimately. And some things it does very well; some things it doesn't do very well. Some very easy things it doesn't do at all and which the brain can do quite easily. It has its limits; it has its excelling moments. But, as with everything, we start to see the relationship of how natural systems and computation and the artificial are becoming one and the same. You're loathe to separate them because once you realize the potential of the recumulative aspect of them, why would you?

Ttarp is a student-run magazine which is Pratt spelled backwards… . One of the recent issues is called "Not Nature." So typically, it sort of looks at the things that are going on in the studios, and we invite other faculty, Stanford, Quintet from Harvard, or Igan from Princeton to contribute as well. But it's mostly Pratt faculty, Pratt students with invited guests, Patrick Schumacher. It's a very interesting publication which basically tries to look self-reflectively upon the situation as it's happening and always creates very interesting feedback because, both in terms of assessment as well as in terms of projection, you're seeing the trends that aren't necessarily prescriptive, but may value more than a second look. So this one on "Not Nature" was really taking a look at that.

What are the relationships between the artificial and the natural? As we – as programs investigate within the studios, within the seminars, within technology seminars, as well as theory seminars, and that, in fact, computation seminars, and then in process is really seen as the work itself. Once you see the work, then how do you start to not just realize what was at stake within the studios, but then what are the tendencies that you can see? What are the trajectories that you see within the programs that are of interest, that are hopes in a certain way?

And what happens if you take that into a more critical realm where we've done, which might engender work that will be done? So I think that level of feedback, reverse feedback between the studios and the theoretical texts is something which almost comes natural to us, and natural to our environment, and is critical to progressing. So I think – at least in the graduate programs, for which is what I'm really in charge with – we like to luxuriate in that position because we find it very productive on the level of idea, as well as the level of artifice.

Well, I think that's one of the reasons we have such an intimate relationship with the faculty. I mean none of our programs, none of our courses frankly, have more than one to eleven students inside them. So it's, really, whether that be studio or seminar, we don't have a lecture format because, I think, at the graduate level, it's a graduate's degree. It's a graduate education; you should be discovering new ways in which to think, new ways in which to make, that there's always a relationship between the critically creative, that it is critical and creative. It's about research rather than routine. And I think it's our position to examine, to critically route practices and define sort of new methods through which to really develop design research, not adopt nor adapt to known conditions. I keep on going to this issue of method, but it's very difficult at this point, I think, and educationally to distinguish idea and method.

And maybe that's why we teach the studios with studio faculty and design studio faculty who are digitally adept and digital instructors who are adept with design. And it's very important to establish the goals, objectives. It's as important to develop methods through which they are realized – and that's a design process in and of itself – along with the design process, which is the larger picture of things. That's where architectural education, and maybe more than architecture education, is today. You're designing the method by any means necessary. So there's a great value in the hybridization of that, and that hybridization is not just about diversity. It's about really strengthening yield, and where do you position yourself in terms of contribution ultimately.

I think you have to, as a student, become very invested within your graduate education. I always say when you would come into the program, you've started your career. Ultimately, you're not here to get a job. This is your life, and it's difficult to assign a number to that. But the faculty that you meet, the students that you meet, this is a network in its best sense, along with the students that you have. And it's in your own generation, and you'd like to think that everyone is very conscious of that and they value that, that it's not just about networking, really. I would like to think that the successes that we see in the program are very aware of that.

Interviewer: Do economic concerns affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

William MacDonald: Of course. We certainly do have budgets. We had to prioritize what we think is important. And in terms of that, we try to be smart about it. We try to make strategic partnerships. One great advantage we have is being in New York, where we have a lot of people we can draw upon, and we have people with very sophisticated machinery that happen to be doing projects in the school that they extend into their own really prototype environment. So it's not just about what we own as a school and program, but we try to involve in different projects and different studios and even in courses, even in course structure, ways in which our students can really have access to the most advanced technological systems that are out there.

Interviewer: Do pressures from the profession affect the way your school has adopted and/or implemented advanced technologies in the design studio curriculum? If yes, how?

William MacDonald: No. We use machinery that the profession doesn't use yet. We're not trying to answer to them. But I would like to believe that they would look to us in many ways. But I think it's important to look at the research aspect of it. And if there's anything that's driving it, it's more in terms of design research and capability and technique, and you're really trying to more push the envelope, if not shred it. The work that is done in those seminars and studios is really groundbreaking work. And it's not necessarily in terms of fostering a relationship in terms of the profession as much as really pushing as far as you can go the development of the new technique.

Interviewer: Do ethical concerns affect the way that your school has adopted and/or implemented advanced technologies in the design studio curriculum?

William MacDonald: . . . I've heard often that there are moments in time where academia drives the profession and profession drives academia. There has to be a certain cross-pollination there… . But certainly, in terms of research and development, academia in a certain way is better built, just naturally. In the profession, it's difficult to get that amount of time relative to responsiveness. That's why you've seen many very fine practitioners teaching in schools; I think that more than 95% of our faculty are practicing architects.

You see that in medicine also in terms of their clinical practices, for example. Practitioners are actually manning university research practices in hospitals and so forth; there's a reason for that. I think it's very similar for us. To a large extent, you have to be committed to practicing what you preach in order for that to really work well . . .

Interviewer: Why do you care Professor, to teach the students these advanced

technologies? Is it because you want to prepare them for the practice?

William MacDonald: I like to really work [on] preparing them to advance our profession forward, not just skills. I would hope we're teaching them a method of thinking and learning in order to go beyond where we've shown them. You'll see that in a lot of the studios, if you ask somebody who chose a studio because they think the professor is going to be doing what they did last semester. Actually, they've moved on from that, and they're doing something completely related but different. And that's great because it means that they've learned from what they've done; they've evolved from what they've done so you can never expect to take the same thing again. And I think that instilling that progressive design environment is something to be really sought after. I would really like to believe that that will happen beyond our academic walls. It certainly happens within. So rather than marketing what you've learned – because technologies will change in six weeks – we get a patch from one of the software companies that we work with very closely that will radically change what we can do. In fact, sometimes it's based on what we've asked them to do.

Interviewer: That change is very stressful. For students, I mean, I think they can't keep up, sometimes.

William MacDonald: Or they can be exciting. Well not necessarily, yeah, I don't think you can ever really be considered expert at software.

Interviewer: Do you think at least they're able to think critically and question their use of these technologies and the use of software?

William MacDonald: Well, I don't know if you're questioning the software as much as you're questioning design… .We always find ourselves in the position of pushing the limits of our boundaries; I would like to think that, rather than necessarily just being expert within them. I think you're right that the education has changed in that way, in the sense that the speed of change has increased dramatically. And I don't know if it's much as keeping up with the speed as much as sort of enjoying being propelled with it.

And there is an increased currency, intensified currency, meaning it's very current to the work that's going on now. It's a good thing because it will offer other opportunities. And I think the important thing is to value it – is to ask, "What is it? What are the benefits of it? What are the advantages of it? What does it get trapped into just doing it because we can?" . . .

Interviewer: It's out there. Go find it.

William MacDonald: Yeah, go find it. We expose people to software. We don't have a class on specific softwares. I mean all the manuals are really written in seventh grade language. What you can't find [in the university] you can find on video, on the web very sophisticated, frankly, at this point, and very clear. They've been done a number of times.

We have our own blog to which our students continually upload specific techniques to.

Interviewer: For each class?

William MacDonald: For each class. And oh, they're shared in what's called a digital media survey that we have . . . So, it's much more about knowing how to go about learning things, sensibility towards the software in architecture, and really about exposure, frankly. And that's done on very broad scape, but also on a very refined tutorial one as well . . . The digital as well as the issues of sustainability are very well ingrained within our student body, as well as our faculty. So, we expect a certain sensibility towards that. I can't say we expect certain adeptness to that because that's what we do. That's what we can teach you. We can teach you design, the way in which you can think about it critically, creatively. So, we approach software in the same way.

We don't teach design in terms of how to do this and then you market that to some firms. I think that that kind of profession doesn't exist there. It's not there anymore. Many firms are sort of inventing the way in which they practice architecture today. The large corporate firms are not so large anymore, not just because of the economy, but because in a way in which architecture is approached. Your small firms are doing large projects, and there's not a – how can I say this? – there's not a direct route which allows quality education to train someone to do something. We're not really educating, and that's a kind of life-long process.

Interviewer: What do you think are the most pressing questions and issues regarding the relationship between architectural education and advanced technologies in the design studio environment?

William MacDonald: . . . In terms of studio education, I think it's one of the best ways I know to educate anyone because it's such a dynamic model and it really operates on so many levels simultaneously in terms of idea, method, production, testing, evaluation, rigor. The relationship to the way we approach technology, the way we approach software, or emerging technology is really from that lens. So, because it's a dynamic model, which is continually adjusting in its own culture as well as to external cultures, I think that's an almost impossible question to answer because you're in the moment. It's a moment of arrival. You're at the moment of departure so it's difficult to gauge what the next big thing is if you are in the midst of evolving it.

Because culture itself [has] so changed the way we work, the way we live, the way we communicate, every aspect of it is really a moving target, and therefore it shouldn't be targeted. It should be evolved with rather than seeing it as a destination to arrive at. The way that we approach issues critically in terms of design is so valuable to society ultimately because we address problems; we polemicize them. It's much more an aspect of continually evolving rather than necessarily saying that this is what is going to be the next trajectory.

Interviewer: Any problems you see with the use of advanced technologies—?

William MacDonald: . . . I think there can be a dependency, false dependency that's created with it because of its immediacy of result. There can be a danger even in thinking, 'If I only had software which could do this,' and then even had people writing that for you, which is occasionally the case. Sometimes, that can be done to avoid issues rather than to take them off. And that avoidance necessarily is not productive. So I think, if anything, there has to be a value in the resistance and the constraints of some things that is not limitless, but shapes the way in which you start to think, start to make, start to act.

And if you're conscious of it then you can guard against what might be considered negative, but you have to be aware of it. There's this sense where you know you push a few buttons, you get a few things. That's not good . . . You have to be very conscious about seeking the resistance, or a resistance, whether that's material or software, in terms of idea, and understanding where attributes might lie there. That's basically a critical position while you are working. If you don't approach it in that way, you arrive at things that have no significance, or no meaning without contribution. Why would you waste your time?

Interviewer: The reasoning, the whys—

William MacDonald: . . . It's a question of also weeding out what you've done, not simply producing what you intend. And it has to do with self-generating systems and open-ended systems, the significance of that . . . Working with digital aspects of technology affords a great ability to transform ideas into architecture, rather than translate ideas into architecture. So that's one thing.

. . .So I have an ideal, and now I'm trying to translate that as close as I can into architecture**,** which always intrinsically means that there's some loss there, versus participating in the transformative act itself . . . You need to think differently and differently critically, rather than necessarily creating a close proximity to idea. I think some narrative work, some metaphorical or analogical conditions, are probably closer to that, some representational work. I think that the computer and the computation and digital research is most successful in that interest in transforming. And that might be a different mindset.

Interviewer: Thanks a lot for your time.

William MacDonald: Oh, well, thanks for coming!

APPENDIX C:

INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Beverly Brandt AED
From:	for Mark Roosa, Chair Soc Beh IRB
Date:	06/03/2011
Committee Action:	**Exemption Granted**
IRB Action Date:	06/03/2011
IRB Protocol #:	1105006487
Study Title:	Architecture and the Machine: The Evolution of Digital Architecture Pedagogy in Conversation with Environment, 1920 to 2011

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2).

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.