Geometry of the Sun:

Guarino Guarini and the Church of San Lorenzo

by

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ABSTRACT

The desire to orient human civilization within the universe is evident in the most ancient structures of the world, including Stonehenge, the Pyramids of Giza and the Pantheon. The baroque architect, priest and polymath, Guarino Guarini (1624–1683), designed seventeen architectural works and wrote ten treatises on a multitude of subjects, including architecture, mathematics and astronomy. Guarini presents three principles in his treatise on architecture, which connects the art of building (*edificare*) to the sun (*orologia*, *gnomonica*) and to solar mechanics (*macchinaria*). The Church of San Lorenzo in Turin (1668–1687) is an elegant example of these principles created as built form, with a dome resembling the celestial sphere, aligning the church to God and to the cosmos. The vertical alignment of the dome represents the celestial pole, a cosmological center point that is also known as the *axis mundi*. The interlocked system of stone arcs that comprise the structure of the dome, represents the rings of an ancient model of the celestial sphere known as an armillary that dates as far back as Eratosthenes (276–194 BC). The following dissertation creates an unprecedented connection between Guarini's knowledge as an architect, mathematician, astronomer and philosopher, to the Church of San Lorenzo. While a previous theory on Guarini by Marcello Fagiolo briefly established the possibility of a system unifying Guarini's architecture and academic knowledge, I greatly expand this possibility and argue that Guarini is a heliocentric astronomer, not a geocentrist. San Lorenzo was built at the end of the Baroque period and at the beginning of the Enlightenment, representing the bridge between the classical past and the dawn of the age of modern science. By demonstrating that Guarini

believed in a sun-centered solar system, I will argue that for Guarini, the light of the sun was architecturally, theologically and cosmologically of the utmost importance.

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This list of acknowledgments, while no doubt incomplete and long overdue includes first and foremost the chair of my dissertation committee, K. Paul Zygas for his encouragement to continue developing as a specialist on Guarino Guarini and to Nancy Serwint for all of your dedication and hard work. Thank you also to John Shannon Hendrix as an outside committee member, with whom I have worked for over a decade in conference presentations and publications. I would like to also acknowledge my prior advisor at Arizona State University, Renzo Baldasso for his role in admitting me to the program at Arizona State University and challenging me greatly during the grueling general exams. Thank you also to the Biblioteche Nazionale di Torino for making it possible to visit Turin and Guarini's Church of San Lorenzo. Thank you also to Marcello Fagiolo, Susan Klaiber, James McQuillan, Nicholas Temple, Nader El-Bizri and Raymond Quek among so many others that have facilitated my education up to this culminating point in my career. As Guarini encourages his patrons to "walk on the stars of the celestial sphere," I hope that you will all enjoy reading "Geometry of the Sun" immensely.

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TIMELINE

1624 Camillo Guarino Guarini is born on the seventh of January in Modena, Italy.

1639 Guarini enters the Theatine Order on the twenty-seventh of January and moves to the novitiate of San Silvestro al Quirinale in Rome.

1647 Guarini takes his vows to the order, returning to Modena immediately thereafter.

1649 Appointed as the site supervisor of the church of San Vincenzo in Modena, working under Bernardo Castagnini.

1650 Entrusted with the position of lecturer in philosophy in the convent of Modena.

1654 Appointed as *procuratore* (legal administrator) of the convent, in place of his older brother Eugenio, who is transferred to Ferrara.

1655 Appointed as *proposito* (provost) of the convent in Modena. Guarini soon renounces the position and is replaced by Castagnini upon Duke Alfonso d'Este's request. Guarini is forced into exile.

1660 Guarini arrives in Messina, Sicily and is appointed professor of mathematics at the Theatine school, where he publishes *La Pietà Trionfante, Tragicommedia Morale* (Messina: Giacomo Mattei). For the next two years, he works on the façade of *Santa Maria Annunziata* (destroyed by earthquake in 1908) and the church of *Padri Somaschi*, which remains unrealized.

1662 Obtains permission to return to Modena to visit his failing mother. He moves to Paris soon after and is commissioned by Cardinal Giulio Raimondi (otherwise known as Jules Mazarin) to build the Theatine church of *Sainte Anne la Royale* (destroyed in 1823).

1665 *Placita Philosophica* (Paris: Augustæ Tavrinorum) is published.

1666 Guarini arrives in Turin. Soon after, he is stationed a Nizza to work on San Gaetano. The project was never realized.

1668 Guarini is commissioned to build San Lorenzo and to serve as engineer on the project of the Chapel of the Holy Shroud.

1671 *Euclides Adauctus* (Pedemontium: Agustæ Tavrinorum) is published.

1674 *Modo di misurare le fabbriche* (Torino: Per gl' Heredi Gianelli) is published.

1676 *Trattato di fortificazione* (Torino: Heredi di Carlo Gianelli) is published.

1683 Guarini dies on the sixth of March. The Chapel of the Holy Shroud and the *Palazzo Ducale* is left unfinished. *Cælestis Mathematicae, Pars Prima et Secunda* (Mediolani: Ex Typographica Ludovici Montiæ) are published posthumously the same year, along with the *Compendio della sfera celeste* (Torino: Augustæ Tavrinorum) and a treatise concerning time and the movement of the planets according to the Aristotelian *primum mobile* entitled, *Leges temporum et planetarum* (Torino: Augustæ Tavrinorum Hæradum Caroli Ianielli).

1737 *Archittetura Civile* (Torino: Apresso Gianfrancesco Mairesse alla Insegna di Santa Teresa di Gesu) is published posthumously.

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GLOSSARY

axis mundi. (*Lat.*) A point on the earth which points out how the earth spins on an axis point as it rotates around the sun. Also, a sacred place which denotes the center of the world for religious cultures where there is often a temple or place of worship.

astrolabe. An instrument used in ancient astronomy to measure the inclination of the stars, the horizon, the zenith, latitude and triangulation.

asymptote. A function of projective geometry in which a line is tangent to a curve at a point that approaches infinity.

categories (Aristotle). A ten-point system of predication (*prædicamenta*, *Lat.*) which describes the nature of different terms according to subject such as substance, quantity and quality, where or when things exist.

celestial sphere. A model of the universe used in cosmography that creates a map of the stars and planets.

chord. An aspect of trigonometry used in architectural design in which a line passes from the edge to the other edge of a circle or an ellipse.

cosmography. The mapping of stars and planetary bodies in space.

cosmology. A branch of philosophy that pertains to the origin and design of the universe.

cupola. (*It.*) The dome of a building, particularly of a church.

directrix. A fixed line in geometry used to describe a curvilinear shape.

elevation. An architectural drawing or diagram depicting the front or side of the building and its vertical dimensions.

fulcrum. The focal point or *axis mundi* around which the earth rotates.

geocentrism. A scientific belief that the sun revolves around the earth.

geodesy. The method of connecting a work of architecture to coordinates on the earth or in space whether symbolic or geographic.

gnomonics. The study and creation of sundials.

heliocentrism. A scientific belief that the earth revolves around the sun.

hermeneutics. A branch of philosophy that pertains to interpretation, particularly of literary sources.

historiography. The study of written history.

horology. The study and measurement of time.

humanism. A school of thought based on the classical knowledge of the Greeks and Romans that was revived during the Renaissance by Petrarch.

hyperbola. An open curve with two branches formed by passing a plane through two conic forms with a conjoined vertex.

ichnography. The floorplan of a building, literally the 'footprint.'

mesolabio. A practical tool invented by Eratosthenes for doubling the cube.

muqarnas. A form of ornamental vaulting found in Islamic architecture that often resembles the form of stalactites or a honeycomb.

nadir. The downward, opposite direction of the zenith from the point of the observer.

oculus. A circular opening in the ceiling of a building that allows the entrance of light.

orthography. An architectural drawing in which three dimensions of the building are depicted in perspective on a two-dimensional surface.

parabola. An open plane curve formed by the intersection of a plane and a conic form.

pendentives. Triangular vaulting that facilitates the intersection between the dome and its supporting archways.

phenomenology. A branch of philosophy that deals with consciousness from a subjective, first-person point of view.

piombo. A hanging lead weight used to determine the level foundation of a building.

praxis. The process of putting a theory into practice.

quadratura. The act of squaring a circle, used in architecture to create domes as well as in painting in the creation of illusionistic ceilings.

syllogistics. A branch of Aristotelian logic that applies deductive reasoning in which the first premise is true to the second, and the second is true to the third, then the first must be true to the third.

zenith. The point in the sky or the celestial sphere directly above the observer, around which the stars appear to rotate.

AUTHOR'S NOTE

As the author of *Geometry of the Sun: Guarino Guarini and the Church of San Lorenzo* I provide this preliminary note to the reader on the following: the translation of primary sources; Guarini's importance in the seventeenth century; the historiography within secondary sources; a brief summary of new research and what may be gained by the contemporary reader.[1]

Within these four subchapters I also defend specific ideas which may be held as serious points of contention without a note of preliminary explanation. These include: the posthumous publication the *Architettura Civile* and its validity as a primary document; the understanding of Guarini as a geocentric astronomer based on the theory of Marcello Fagiolo and a point of clarification concerning Guarini's prescient scientific discoveries prior to the Enlightenment.

Geometry of the Sun presents a theory of the Church of San Lorenzo, built at the height of Guarini's productive period as an architect in the northern Italian city of Turin. It is a theory based on the principles of mathematics found in Guarini's treatises on the subjects of architecture, geometry, astronomy and philosophy that I apply to an intricate geometric analysis of the church. At the core of this theory is a remarkable understanding of the movement of light within the church as it revolves around the sun from a vantage point called the *Axis Mundi*.

[1] All translations in the following dissertation are provided the author unless otherwise noted.

Translation

Geometry of the Sun presents a theoretical understanding of the Church of San Lorenzo based on the written works of the architect Guarino Guarini. Because of my reliance on the architect's treatises as a primary source, I provide this note concerning translation and interpretation.

I have been meticulous in providing a close and careful translation from the architect's original publication. Parenthetical interpolation of Guarini's words in their original language without alteration is provided in-text and has been carefully footnoted for easy reference. My intention in doing so is to provide a method of clear interpretation, brevity of language and a presentation of the core theory that can be seen clearly in Guarini's own words as they relate to the church of San Lorenzo, as presented in Part II.

Guarino Guarini is the author of ten published works: *La Pietà Trionfante* (The Triumph of Mercy, 1660); *Placita Philosophica* (A System of Philosophy, 1665); *Euclides Adauctus* (The Advancement of Euclid, 1671); *Modo di Misurare le Fabbriche* (Methods of Measurement for Construction, 1674); *Trattato di Fortificazione* (Treatise on fortifications, 1676); *Cælestis Mathematicae, Pars Prima et Secunda* (Celestial Mathematics, 1683); *Compendio della Sfera Celeste* (Compendium of the Celestial Sphere, 1683); *Leges Temporum et Planetarum* (The Laws of Time and the Planets, 1683); *Dissegni d'architettura civile, et ecclesiastica* (Designs for Civil and Ecclesiastical Architecture, 1683); *Architettura Civile* (Civil Architecture, 1737).

All of Guarini's treatises are written in Latin except for the *Architettura Civile*, which was published posthumously in the Italian vernacular. The posthumous publication of the *Civile*, admittedly puts into question the core inquiry of my thesis for three reasons: first, because so much is left open to second-hand interpretation and misinterpretation as a written manuscript that was published fifty-four years after his death; second, because the thesis that I present herein comes directly out of the *Civile* and because, in principle, my own thesis is the same as Guarini's thesis statement in the *Civile*; third, because the nature of research, especially regarding the creative endeavors of artists and architects, often pertains less to the individual who made such claims or such works during the course of their life—particularly when it pertains to what is seemingly the most obvious of those claims.[2]

The *Dissegni d'architettura, et ecclesiastica*, a series of thirty-three engravings of the footprints and elevations of Guarini's architectural designs was published three years after Guarini's passing in 1686. A series of geometric figures and diagrams in the rear of the *Dissegni* represent many of the fundamental shapes and architectonic forms which are found within Guarini's buildings. These figures and diagrams align with the text of the treatise and its various chapters, subchapters and observations according to notations in the margin. The *Dissegni d' Architettura* was published and included at the end of the *Civile*.[3]

The *Architettura Civile* was published by Gianfrancesco Mairesse in Turin in 1737.[4] According to a letter written by the head of the Theatine Order on October twenty-

[2] Dalibor Vesely, *Architecture in the Age of Divided Representation* (Cambridge, MA: MIT Press, 2004), 201. "Critics [*sic*] often tend to underestimate the link between Guarini's *Architettura Civile* and his philosophical and scientific writings."
[3] Guarino Guarini, *Dissegni d'Architettura Civile et Ecclesiastica* (Torino: Per gl'eredi Gianelli, 1686), 1.
[4] For a detailed description of Guarini's designs, and the engravings produced for the *Dissegni d'architettura Civile*, see: Aldo Bertini, "Il Disegno del Guarini e le Incisioni del Trattato di 'Architettura Civile'" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademia delle Scienze, 1970), 597–610.

second, 1735, Bernardo Vittone was hired to edit the text of the treatise.[5] D. Nicolaus Antinori, Provost General of the Theatines also provides mention of Vittone in the Note to the Reader (*Avviso a Lettori*) in the 1737 publication of the *Architettura Civile*. Antinori expresses Vittone's role in "cleaning up and recompiling" (*la fatica di ripulirla, e reunirla*) Guarini's original manuscript. In Antinori's inscription (*Facultas Reverendissimi Patris*), he provides his own statement as the compiler and editor of the treatise, inscribed with the same date as the letter by the head of the Theatine Order (*Romae die 22 Octobris 1735*). Antinori states that while there was clerical approval of the manuscript (*iuxta assertionem Patrum, quibus id commisimus approbatum*), they have chosen to present the book in a form that has been "appropriately appended" (*quorum sidem praesentes litteras manu propria subscripsimus*).[6]

The discrepancy between Vittone's commission as editor and Antinori's self-proclaiming foreword is a point of contention which may lead to a number of conclusions. In the 1735 letter, it is apparent that Vittone may have been hired only as an aid in editing and translation, which may attest to the nature of Antinori's foreword in the 1737 publication. However, it is also possible that Antinori, while taking undue credit for Vittone's work as a translator, is stating his role in appending (*subscripsimus*) the manuscript as a censor.

[5] Richard Pommer, "Costanzo Michela and Santa Maria in Agliè: A Guarinesque Rarity" *The Art Bulletin* 50, 3 (1968): 176.

[6] Guarino Guarini, *Architettura Civile* (Torino: Appresso Gianfrancesco Mairesse all Insegna di Santa Teresa di Gesu', 1737) [Facultas Reverendissimi Patris]. "*Hoc Opus inscriptum* Architettura Civile *à q. P.D. Guarino Guarino compositum, & iuxta assertionem Patrum, quibus id commissimus approbatum, ut Typis mandetur, quo ad nos spectat facultatem concedimus. In quorum sidem præsentes Litteras manu propria subscripsimus, & solito nostro Sigillo firmavimus. Romæ die 22 Octobris 1735.*"

The greatest challenge of sifting out Guarini's original manuscript from the publication of 1737 lies in the lack of folio pages that have survived.[7]

The dedication of several of Guarini's treatises to his patrons, including the *Architettura Civile*, the *Placita Philosophica*, the *Compendio della Sfera Celeste* and the *Modo di Misurare le Fabbriche* (Methods of Measurement and Building) is reliant on the patronage of those in financial and political power to finance his literary endeavors as well as his architectural projects.

By addressing his patrons in the dedicatory foreword, he is assuring a productive working relationship with individuals whose motivations and desires concerning the proliferation of architecture and the advancements of science are in many ways profoundly divergent from his own. The late Baroque period in which Guarini worked presented a period of advancement among individuals interested in the understanding and exploration of the universe, which also presented an opportunity for dynastic advancement on behalf of the Savoy involving political domination and the advancement of the duchy. The reliance on dominant powers is a problem throughout the history of the Catholic Church and of civilization, in general. The problem concerns the development of knowledge and civilization coveted by the ownership and dominion of such powers.

Guarini's relationship to the Savoy Dynasty as a Theatine priest led to success and the building of the majority of his realized projects. However, the patronal influence of the monarchy affects what is written, what may or may not be included in the final printing,

[7] Bertini, "Disegno del Guarini," 597. "*Qualunque considerazione sul disegno di Guarini, data la scarsità di fogli suoi, e la problematicità delle attribuzioni, deve partire dale tavole dei* Disegni di Architettura*, pubblicate senza testo tre anni dopo la morte del Maestro, che portano la chiara attestazione sul frontespizio 'inventati e delineati dal padre D. Guarino Guarini modenese' e ristampate con poche aggiunte nel successivo trattato di* Architettura civile *curato dal Vittone.*"; In considering this point of contention involving the *Civile*, my goal in Part Two: Geometry of the Sun, is to progress toward an understanding of the manuscript by connecting the engravings and geometric diagrams to the text.

and how architectural or theoretical concepts and ideas are stated in the treatise. Guarini's goal in writing for the Savoy Dynasty is to utilize his knowledge of universalism in astronomy and mathematics to give the monarchy a seat of power.

The *Modo di Misurare le Fabbriche* is dedicated to the painter Giovanni Andrea Ferrari (1598–1669), Count of Bagnolo and minister of finance for the architect and engineer Amedeo di Castellamonte (1610–1683). Guarini states that the purpose of the treatise is to transform the House of Savoy into a machine that is perfectly aligned to the movement of the celestial sphere (*tanto bene moderna questa machina, che non vi e movimento di sfera sì perfettamente aggiustato*), thereby allowing Ferrari to better serve as minister of finance to the Duke of Savoy, Vittorio Amedeo I.[8]

Much like Guarini's dedication to Torres in the *Placita Philosophica* and Ferrari in the *Modo di Misurare*, the commemoration of the *Compendio* to Truchi discusses the celestial sphere, not only in light of astronomy but in terms of politics and power. Guarini expresses that while the effect of his book may be small, its subject matter is of vast proportion and may serve to amplify the power of the duke (*Effeto è il libro delle mie deboli forze, la materia di lui è una vastità proportionata all' ampie sue prerogative*).[9]

Guarini states that the sphere (*così questa mia sfera*) will be like nothing else that has ever affected the greatness of Ferrari's intellect (*sarà come niente capita dal suo gran intelleto*), effectively putting the duke at the center of command (*al centro di suoi ambiti commandi*).[10] Guarini also emphasizes that the heavens are at the duke's disposal; that they have no other locus than him at the center (*questo nostro cielo non hà altro loco*), appealing

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[8] Guarino Guarini, *Modo di Misurare le Fabbriche* (Turin: Per gl'Heredi Gianelli, 1674), 3–4.
[9] Guarino Guarini, *Compendio della Sfera Celeste* (Turin: Giorgio Colonna, 1675), (unpaginated).
[10] Ibid., (unpaginated).

not merely to the fervent desire to rule, but also alluding to the egocentric adherence to geocentric theory that came along with it in the seventeenth century.[11]

Guarini's dedicatory foreword to Ferrari creates a synthesis of cosmology and politics that connects the celestial sphere to the sphere of political influence surrounding the Savoy Dynasty. This complex dynamic, involving power and belief, domination and geographic exploration, first appears at the beginning of the Renaissance with Francesco Petrarca (1304–1374) and the philosophy of Humanism.[12]

The rediscovery of Cicero's writings by Petrarch (1304–1374) brought about the rediscovery of classical antiquity and the blooming of Renaissance culture. Petrarch is important for the contemporary scholar to rediscover in a world that seems to have fallen into a much darker age than the age prior to Petrarch. A relevant passage from Cicero cited in Petrarch's *Epistolorum* represents the idea of the *axis mundi* and the Humanist desire to orient ourselves to the heavens: "everything which is contained within expands from Rome and is connected to this defined locus, this fixed location in the heavens" (*omnibus qui patriam conservaverint, auxerint, adivverunt, certum esse in caelo definitum locum*).[13]

This interrelationship between cosmology and state power is also expressed in Cicero's *Oratore* as well. According to the Platonic foundation of Cicero's philosophy, the elements of political rhetoric, science and physics must be used integrally in governance

[11] Ibid., (unpaginated).
[12] Ernst Cassirer, Paul Oskar Kristeller and John Herman Randall, Jr., eds. *The Renaissance Philosophy of Man* (Chicago and London: The University of Chicago Press, 1948), 11, 15, 19.
[13] Francesco Petrarchae, *Philosophi, Oratoris et Poetæ* (Lyon: Apud Samuelem Crispinum, 1601), 99. Interestingly, Petrarch's reference to Cicero pertains to the Roman politician's notes on Africa (*notum est apud Ciceronem cæleste illud Africani mei dictum*). Petrarch's *Epistolorum*, a letter expressing the desire to fulfill the work set forth by the apostles, becomes entangled in a complex, multifaceted rhetoric of catechetical politics. The guiding principle of politics according to Petrarch, is to fulfill the will of God (*optimo principio pollíticus es ut in omni fortuna Deum*), something which reflects a seventeenth-century idea of manifest destiny.

and for the advancement of state power (*civilem scientiam, euius pars est rhetorice, transferenda: & eorum fontes videndi potius*).[14]

Both Ferrari and Castellamonte received a classical education that, no doubt, included the persuasive art of rhetoric. Ferrari studied classical literature prior to becoming a painter; Castellamonte studied law at the University of Turin. The training of the royal elite in the seventeenth century, like most forms of governance, was a form financial and geographic control and dominance. Relying on the patronage of the monarchy, Guarini appealed to the sumptuous power of desire, and the desire for power expressed in the lavish decorum of the Baroque, while demonstrating a profound knowledge of the universe within his cosmology and architectural design.

Similarly stated in the *Architettura Civile*, the rotation of the earth upon its axis creates torque, converting physical force to angular momentum (*quando gyros, quos circa mundum sol torquet*).[15] This transfer of power (*redigere*), creates structural order and unity,

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[14] M.T. Ciceronis, *De Oratore ad Quintum Fratrem Dialogi Tres* (Paris: Ex Typographia Thomæ Richardi, sub Bibliis aureis, è regione collegij Remensis, 1561), 268. This passage from the *Oratore*, describes this transferable relationship between political rhetoric, science and physics, which according to the Platonic foundation of Cicero's political philosophy, was intended to be seen as an integral system: "*De iustitia publica præcipit Plato in libris de Rep. de officio Panetius, de civitatibus instituendis & regendis Plato de legibus & de Rep. & Aristoteles in Politicis. De omni ratione vivédi, idem Aristoteles in Ethicis. De ratione nature, idem in Physicis. Hæc quoniam iam aliunde accipi non possunt, sumenda sunt oratoribus à philosophis: à quibus expilati, direpti, spoliatique sunt: nec discenda tractadá ve eo modo quo solet illi, sed ad civilem scientiam, euius pars est rhetorice, transferenda: & eorum fontes videndi potius, quàm omnes omni ætate rivuli consectandi.*"; 213. Martullii Ciceronis, *De Oratore, Libri III* (Venice: Apud Cominum de Tridino Montisferrati, 1544), 213. Another example from *De Oratore* is given here, in which Cicero states that the embellishment of language with the knowledge of art and science enriches the readings of orators and poets. "*…Sed omnis loquendi elegantia, quanquã expolitur scientia literaru, tamen augetur legedis oratoribis & poëtis…*" Glare ed., *Oxford Latin Dictionary*, 1590.; Ferrari and Griffith's introduction to *The Republic* expresses the following statement (which is actually due to the influence of Socrates), a reason behind Cicero's reliance on Platonism, that "the knowledge which truly qualifies a guardian to rule is philisophical wisdom, having for its object the whole cosmos." Plato, *The Republic*, ed. G.R.F. Ferrari and trans. by Tom Griffith (Cambridge, UK, Cambridge University Press, 2000), xxix–xxx.; Gustavus Fischer, *Latin Grammar, Together with a Systematic Treatment of Latin Composition, Part Second, Containing the Details of Syntax* (New York: J.W. Schermerhorn & Co. Publishers, 1876), 547.

[15] Guarini, *Placita*, 304; Ibid., 304. "*…namque corpora nonrotunda, in gyrú se moventia, in equalibus angulus, modò locum reliquunt, modò occupant; ut videre est, si quadratum in orbem torqueatur.*"

like the cartographic divisions of planes and rectilinear surfaces projecting outward from the spherical surface of the earth (*quin redigeret omnis fere in quadrum numerumque sententias*).

Guarini's career as an architect, scientist and priest, seemingly relied on an appeal to state power, in which the church is used as a means to an end, rather than an exploration of the divine cosmos. While the monarchy often sees the politically minded view of religion as a way in, as an access to power, the religious orders see the church as the way out; a way to open the doors of the infinite through the *chiave della chiesa*.

The beauty and challenge in writing a dissertation about Guarini is that it is most effectively understood *vis-à-vis* Guarini. While understanding Guarini's work through the pragmatic text of the *Civile* in relation to the Church of San Lorenzo is a direct, heuristic approach, the late publication date makes the premise of the thesis rather elusive in a manner that may also be considered Guarini *vis-à-vis* an interpretation of Vittone.

The solution to this elusivity can be understood by reading Guarini's first published treatise, the *Placita Philosophica* (A System of Philosophy). The proemia (*Præparatio ad Logicam*), entitled '*Quid sit Terminus*' (that which comes at the end), places the limit, the end of knowledge (*scientia*) at the beginning, perhaps like most books that present the conclusion of the essay in the thesis. This method differs, however, in Guarini's *Placita* from that in a modern essay. The proemia is significant to understanding Guarini because it demonstrates his cognitive method, his system of universal logic and how he applies this system to his theory of architecture to put the universe in motion.

Quid sit Terminus defines the three cognitive operations; those being the auditory understanding of simple concepts and the extrinsic opposition and acceptance of intellectual ideas; the function of judgment in what we understand; and discursive reasoning which may to some extent be deductive.[16] The limit, the ultimate end of knowledge, is the primary apprehension of that which is initially understood by the mind (*terminus ergo est ille, qui primò per apprehensionem primam concipitur*).[17] The end of knowledge is essentially the beginning; the limit is the ultimate *a priori*. The voice of human intelligence is not the end of being (*scilicet in voce, homo, hominem non esse terminum*), rather to be human, in and of itself, is being and existence (*esse ipsius hominis*).[18]

Guarini presents the subjects of name (*nomine*), verb (*verbo*), and oration (*oratione*), of propositions and their opposites, modes of enunciation, and syllogistics.[19] Syllogistics, as a method of inductive reasoning, brings together the enumeration of singular and combined concepts, in order to arrive at a universal conclusion (*inductio est argumentum*

[16] Guarini, *Placita*, 1. "*Notandum 1. tres esse intellecutus operationes: Prima apprehensiva vocatur, & haec simpliciter rem apprehendit, & ab extrinseco obiecto assumens in intellectu ponit. 2. Operatio iudicat de re apprehensa, scilicet, an bona, vel mala sit, an talis, vel talis sit, & haec affirmat, vel negat. 3. est Discursus, qui à re iudicatâ aliquid deducit…*"
[17] Ibid.; Aristotle, *Metaphysics*, trans. Richard Hope (New York: Columbia University Press, 1952), 112. "Limit means the last point of anything; that is, the first point beyond which it is not possible to find any part, and the first point within which all the points are. It means the form, whatever it may be, of a spatial magnitude or of what has magnitude. It means also the end of anything, that to which, not from which, a movement or action proceeds; but sometimes it means both beginning and end. It means, finally, the wherefore, the primary being, the 'what' of anything; for these are the limits of knowledge, and, if of knowledge, then also of things. Thus, it is evident that 'limit' means as many different things as does 'beginning,' and even more; for a beginning is in a sense a limit, but not every limit is a beginning."
[18] Guarini, *Placita*, 1. "*Terminus ergo est ille, qui primò per apprehensionem primam concipitur…Ego verò existimo terminum non esse vocem, seu verbum litteris, syllabisque compositum, quod voce sonamus: sed esse illam vim, quam habet repraesentadi illum conceptum, qui per primam apprehensionem in mente nostrâ habetur; scilicet in voce, homo, hominem non esse terminum; sed illud, quod per vocem hominis intelligitur, scilicet esse ipsius hominis: hoc posito, sit.*"
[19] Ibid., 7.; Aristotle, *The Categories. On Interpretation. Prior Analytics*, trans. Harold P. Cook and Hugh Tredennick (Cambridge, MA: Harvard University Press, 1938), 199–223.; Syllogistics is also a topic in Aristotle, *Posterior Analytics, Topica*, ed. and trans. Hugh Tredennick and E.S. Forster (Cambridge, MA: Harvard University Press, 1960), 25, 33.

à recensione aliquorum singularium ad colligendam conclusionem universalem). Guarini's explication of this form of logic, originally found in the *Prior Analytics* of Aristotle, is elegantly applied to Catholic theology, in which God the father and Christ are interconnected: *Pater est Deus, Filius est Deus, ergo Pater est Filius*.[20]

Syllogism is evident throughout Guarini's treatises, as well as, most importantly, in his architecture theory itself, in which architecture, light and geometry interrelate within a trinity of their own—God the universe (*Deus*); the architect (*Pater*); and Christ the light (*Filius*); therefore, architecture (*edifizio*), is related to the light of the sun (*orologia*, *gnomonica*) and the geometry (*macchinaria*) of its movement.[21] This system of logic creates a unification of architecture to theology, astronomy and the cosmos.

The *Placita* continues by defining rational being, universals, identity and distinction, of genus and species, the Aristotelian categories (*praedicamenta*), *accidens*, measure and relation. The universality of this logic is applicable to the practical methods that constitute Guarini's architecture, mathematics and astronomy. Through syllogistics, universal relates to particular, abstraction to specificity. Metaphysics is an entity of precision for the examination of intellectual work, allowing the grace of the universal word (*metaphysica entia praecisa per opus intellectus consideret, verbi gratía universale*).[22]

The first Disputation on Whether Logic is Knowledge (*An Logica sit Scientia*), states that reason is that which allows the unification of universal objectivity (*ratio est, quia habet unicum obiectum universale*). The elements of this objectivity become a body

[20] Guarini, *Placita*, 8.
[21] Guarino Guarini, *Civile*, 1. "*L'Architettura secondo i vari generi della fabbriche così variamente distinguesi. Vitruvio al lib. I, cap. 3, la distinse prima in tre, cioè in Arte di edificare, in Arte di fare orologia, o Gnomonica, ed in Mecanica, o Macchinaria…*". Guarino Guarini, *Architettura Civile*, ed. Bianca Tavassi la Greca (Milano: Il Polifilo, 1968), fn., 6. "Vitruvius: *Partes ipsius architecturae sunt tres: aedificatio, gnomonice, machinato*."
[22] Guarini, *Placita*, 13.

put into motion; the physics of the universe (*alia scientia corpus sub ratione mobilis*; *nisi Physica*), like shafts of corpuscular sunlight penetrating San Lorenzo's fenestrated dome as the church circumnavigates our closest star from its terrestrial axis.[23]

Book Two pertains to physics (*Physicae*) and how they pertain to the *materia prima*, substantial form, total composition, nature and art, causes, actions, time and duration, infinity, location and void. Guarini conveys the importance of delineating between the philosophy of physics, mathematics and metaphysics; physics pertains to the perfection of matter (*physicam à materiâ perfectionis*), while metaphysics pertains to matter of abstraction (*metaphysicam ab omni materiâ esse abstractam*) and mathematics pertains to the quantification of matter (*mathematicam à materiali quantitatis*).[24]

The philosophical division between perfection, abstraction and quantification, clarifies these three disciplines by creating a contradistinction, yet their connection is universally apparent as well. Applied to architecture, the perfection of form is dependent on this method of abstraction, as well as quantification, infinitude and mensuration. As infinity is immensurable, quantification becomes possible primarily through the perfection of matter, brought about by the connection of form to universality.

The first universal causation in Guarini's physics is the *materia prima*. As the syllogistic trinity exists between God as both Father and Son, the *materia prima* exists in the form of three principles: the transmutation of natural bodies according to their first and preeminent cause; this transmutation interacts and envelops existence in a manner that is

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[23] Ibid., 15.

[24] Ibid., 180. "*Aliqui dividunt Philosophiam in Physicam, Mathematicam, & Metaphysicam, desumentes divisiones rationes à diversa abstractione, cum Arist. 2. Phys. à tex. 16. usque ad tex. 18. & 6. Metaph. cap. 1. & 1. de anim. tex. 17 it ut velit Metaphysicam ab omni materiâ esse abstractam; Physicam à materiâ perfectionis, nempe eius, que spectat ad essentialem rei constitutionem; Mathematicam à materiali Quantitatis.*"

not always accessible to the senses; and while the *materia prima* is not dependent on physical considerations, it is the root, the foundation and, therefore, the source of everything sought in nature.[25]

Guarini defines the *materia prima* according to the existence of form (*an materia existat per existentiam formae*). Referring to the metaphysics of his contemporary, Pasqualigum Angelus Bossius (fl. 1665), Guarini defines existence as rational form (*existentia est ratio formalis*), which exists as being and which connects with other forms. While it is not possible to distinguish existence from essence, nothing is other than essence itself (*nihil est aliud quàm essentia ipsa*).[26]

The definition of *materia prima* leads to several disputations on substantial form (*De forma substantiali*), total composition and the unification of created form (*De toto composito*), on nature and art (*De natura, et arte*), on common causes (*De causis in communi*), on action, endurance and movement (*De actione, passione, et motu*), on time and duration (*De tempore et duratione*) and the continuation of composition (*De continui compositione*).[27] The goal of these disputations is to convey the coincidence of metaphysical concepts with physical causation, form and movement in nature, with art and composition of design, the subjects of which are directly related to Guarini's theory of architecture.

Because the *Placita* represents Guarini's system of philosophy, it is significant to consider the proemia of his treatise in the context of writing, translation and interpretation, as it reveals how the Guarini uses language. Clarity of translation is important in the following dissertation as it can be applied as a solid method of interpretation for all of his

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[25] Ibid., 183.
[26] Ibid., 184.
[27] Ibid., 197–266.

treatises which follow the *Placita*. The direct interpretation of written concepts in all of his treatises are also applicable to the architectural forms which Guarini uses in the design of the Church of San Lorenzo.

Influence and Importance as an Architect in the Seventeenth Century

The importance of Guarini as an architect and thinker in the seventeenth century is as complex and polyvalent as the geometry he uses in building. His influential presence in church building can be seen among his close contemporaries in both the north and south of Italy in the work of Achille Carducci (1644–1712), Costanzo Michela (1689–1754) and Domenico Antonio Vaccaro (1678–1748).

The importance of his work manifests in the brilliant connection he builds between architecture and science, guided by a mysterious fascination with the light of the sun that permeates the Church of San Lorenzo. His work comes at a point in history in which the understanding of science was quickly expanding our idea of the universe but also seemingly making the universe more expansive and farther away.

By building San Lorenzo, Guarini's desire is to bring the universe closer to humankind in order to reveal the brilliance of not only the sun but also of the stars. He accomplishes this by combining the universal knowledge gathered by not only his own religion as a priest, but by *las tres culturas*, the three great religions of the west, Catholicism, Judaism and Islam.

The progression of his work is clear according to the path that determined the course of his life. As a seminarian in Rome, he saw the work of the great papal architects, as well as the work of his close contemporaries, already ruling the Roman skyline of the early Baroque period. During his early career, Guarini's divergent mind led to his temporary exile from the Theatine Order, distancing him geographically as well as broadening his knowledge of architecture beyond the Apennine peninsula to Spain, Portugal and France. Due to his expulsion, his penance became his sojourn and his travels became the source of far-reaching knowledge that guides his later work in building.

In 1660, Guarini was appointed to a professorial position at the archiepiscopal seminary in Messina, Sicily which would set the course of his work as an architect and his devotion to the study of light and ocular vision. During his tenure at the seminary, Guarini taught mathematics and philosophy and was commissioned with several architectural projects which he pursued over the next two years, including the design of the façade of Santa Maria Annunziata, as well as the adjacent Convento di San Vincenzo, the Church of San Filippo and a church for the Padri Somaschi, a religious order founded in devotional service of the poor by San Gerolamo Emiliani (1486–1537) in 1532.[28]

The construction of Santa Maria Annunziata began in the decade that followed the arrival of the Theatine Order in Messina in 1607. The body of the church was nearing completion at the time of Guarini's arrival in 1660 at which point he was commissioned to design the façade and to draft plans for the convent. The Annunziata was consecrated on June thirteenth of that year by Simeon Carafa Roccella who served as the Theatine Archbishop of Messina from 1647 to 1676.

Guarini also published his first literary work during his time in Messina, entitled *La Pietà Trionfante*. Guarini developed *La Pietà* into a play that was performed by the

[28] Ibid., Meek notes that the inwardly concave form of the façade of this church is one evident comparison to the work of Francesco Borromini, and his Oratory of San Filippo Neri in Rome.; Nino Carboneri, "Introduzione," in Guarino Guarini, *Architettura Civile* (Milano: Edizioni Il Polifilo), xii. "*Nel 1660 è a Messina: non si hanno informazioni sul period intermedio, durante il quale dovette viaggiare molto, come si deduce dalla presentazione della* Pietà Trionfante, *pubblicata a Messina nel 1660, in cui è definite* '*Mercurio del Nostro Secolo*'" Meek, *Guarino Guarini*, 19. Meek also argues the fact that the only record of Guarini's arrival is due to the publication of Guarini's play, *La pietà trionfante*, which was written to be performed by the youths of the local seminary. He also is unsure of the 1660 date and says that it may have been 1659 or 1660.

students of the seminary. The story resembles the character play and moral allegory present in Greek myths, and particularly the allegory of sight. The profundity of ocular vision and of light is a recurrent trope throughout Guarini's written works and is as ever-present within this passage:

The clarity of light in your eyes, in your pupils
My greatest vow is to you:
But if the hours of your light fade away
rendering my pupils useless
the light within the darkness I will enjoy and praise.

Tu pur dell'occhi tuoi lume, e pupille
Più siate mi giurasti:
Ma se a gli orrori tuoi lume non porge
d'inutile pupilla,
di tenebrosa luce io godo i vanti.[29]

Guarini's *Trionfante* expresses a polyvalent relationship between darkness and light, in which light passes through the cornea and is absorbed within the darkness of the pupil at the center of the iris, striking the retina deep within the eye. In relating this to the use of light in architecture, the pupil represents the oculus which allows light to enter through the dome (*cupola*) or roof (*copertura*); the iris, in all its intricate beauty, represents the dome around which the oculus is built. Guarini's poetic love affair with light manifests in every aspect of his writing and his architecture.[30]

The relationship between light and the anatomy of the eye is most clearly seen in the design of San Lorenzo, the iris resembling the structural interface of stone vaulting in the dome; the pupil resembling the lantern. However, the lantern of the dome during the

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[29] Guarino Guarini, *La Pietà Trionfante, Tragicommedia Morale* (Messina: Giacomo Mattei, 1660), 167.; Fagiolo, "L'Enigma," 211.; John Beldon Scott, *Architecture for the Shroud: Relic and Ritual in Turin* (Chicago and London: The University of Chicago Press, 2003), 211.; Biblia Sacra Vulgata, Ioannes, 1:5.
[30] Guarini, *Placita*, 711–16. Guarini describes, in anatomical intricacy, the connection between the eye, optical vision and its relationship to architecture in *Disputatio VIII*, *Expensio I*, "On the Eyes as the Miracle of Architecture" (*De Oculi Mirabili Architectura*).

day is not in darkness but emits the greatest intensity of light due to the abundance of fenestrations within it. Daylight shifts within the dome according to the motion of the earth around the sun, leaving the lantern and the drum in the darkness of night with the passing of the day.

The importance of light in Guarini's *Trionfante* is evident within every treatise published thereafter. However, the meaning of light in these treatises, like everything in Guarini's mind is multidimensional; applicable to the designs of domes and their fenestrations as it is appealing to the political prowess of the monarchy and to theology and cosmology.

The commission of Santa Maria Annunziata established Guarini's presence as an architect in southern Italy. Several longitudinal churches built after Santa Maria Annunziata reveal the strong influence of a Guarinian aesthetic. A high level of experimentation with Euclidean forms exists in these buildings as well, expressing a similar polymorphic style found in Guarini's other work, as well as a complex love affair with sunlight. The allegory in *La Pietà Trionfante* presents the intersection of forms in his own buildings as well as those of influenced by his work. Guarini's complex use of symbolic form represents light as the generative element of creation itself.

Upon leaving the project at Messina, Guarini devoted the next five years of his life to writing his most comprehensive treatise, the *Placita Philosophica*.[31] It is a massive,

[31] Henry Millon, "La Geometria nel Linguaggio Architettonico del Guarini" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademia delle Scienze, 1970), 47. "*...Guarini trasforma elementi decorativi in elementi funzionali e viceversa, al fine di raggiungere quel risultato figurativo che accentua il quasi umano rapporto tra le masse e gli spazi, e tra gli elementi e la loro relazione con la luce simbolicamente interpretata come elemento generatore della vita.*"; The church of Santa Maria Annunziata was destroyed by a massive earthquake in 1908 along with the cities of Messina and Reggio Calabria. Allied forces invaded the city of Messina during Operation Husky in 1943, with the noble intention of liberating Sicily from the fascist grip of Hitler and Mussolini, but at the cost of levelling anything once again that had been rebuilt since the earthquake. The destruction of Messina by the violence of nature and war has obstructed our ability to form a solid historiography of Guarini's Sicilian journey, or to recreate the Annunziata from the remaining

eight-hundred-page work that sets forth his system of philosophy, by which all else is guided in his life's work. It is a comprehensive, pragmatic system, spanning the fields of logic, anatomy, biology, astronomy, physics, theology and metaphysics. The *Placita* also sets forth Guarini's deeply-felt belief in the importance of light as the preeminent substance that exists prior to all else in nature, which he bases on Genesis.

The theology of *creatio ex nihilo* present in Genesis, in which God brings forth light from the face of the abyss (*terra autem inanis et vacua et tenebrae super faciem abyssi et Spiritus dei ferebatur super aquas. Dixituqe Deus fiat lux et facta est lux*, Gen. 1:2–3), is interpreted as God bearing the full brunt of its weight (*expensionibus in lucem dedimus*).[32] Light is the spirit upon the face of the abyss which brings forth the division of day into night (*divisit lucem ac tenebras*, Gen. 4:4); a horological, gnomonical principle, signifying the rising of the sun and its movement across the sky, revealing the nocturnal firmament (*vocavitque Deus firmamentum caelum*, Gen. 4:7).[33] This is the idea of creation that is at the core of his theory of building.

The relationship between light and the anatomy of the eye is most clearly seen in the design of the dome and lantern of San Lorenzo, the iris resembling the structural interface of stone vaulting in the dome; the pupil resembling the lantern. However, the lantern of the dome during the day is not in darkness, rather it conducts the greatest intensity of light due to the abundance of fenestrations and its exiguous dimensions. Daylight shifts

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stone fragments stored today within the Museo Nazionale.; Borsi, "Guarini a Messina," 71.; Ibid., 73. "*...pochi frammenti marmorei raccolti nello spiazzato del Museum Nazionale.*"; Carboneri, "Introduzione," xii.

[32] Guarini, *Placita*, 407. This definition of light is presented in *Disputatio II*, On Being (*De Ente*).; Gryson, ed. *Biblia Sacra: Iuxta Vulgatam*, 14.; Guarini, *Placita*, 853. Guarini's use of the word *expensionibus*, defined as "to lift out by measurement of weight," relates to the use of the word *ferebatur* in Genesis, meaning "to bear the weight of."

[33] Gryson ed., *Biblia Sacra: Iuxta Vulgatum*, 14.

within the interior of the church according to the motion of the earth around the sun, leaving the lantern and the drum in the darkness of night with the passing of the day.

Established Research

The historiography on Guarino Guarini developed rather slowly over the past three centuries; the main emphasis being on his architecture and a very cursory understanding of the architect's literary *œuvre*. What follows is a brief and critical chronology of this historiographical development from my own vantage point.

The critical reception of Guarini's work over the past four centuries reveals the battered reputation of an architect who is not well understood.[34] The Neoclassical architects of the subsequent century fostered a sense of hostility toward the Baroque, seeing it as nonsensical and bizarre. The mid-eighteenth-century critic Francesco Milizia (1725–1798) claimed that anyone who publicly appreciated Guarini's architecture would be counted "among the cranks."[35]

[34] Meek, Guarino Guarini, 2. "...Guarini's architectural language is so fantastic, original and strange, that it defies any attempt to classify it. Guarini, in a word, is not the product of an ambience: he is the creator of one."; David R. Coffin, "Padre Guarino Guarini in Paris" *Journal of the Society of Architectural Historians* 15, 2 (1956): 3. Coffin quotes the Bolognese priest Sebastiano Locatelli, upon seeing Guarini's church of Sainte Anne la Royale in Paris, as saying, "the plan of this new church is so bizarre that I have never seen any church to resemble it, even in part."; For critically negative accounts of Guarini and his work, see: Wittkower, *Studies in the Italian Baroque* (London: Thames and Hudson, 1975), 178; Francesco Milizia, *Memorie degli architetti antichi e moderni*, (Bassano: A Spesi Remondini di Venezia, 1785), also referenced in a later version: Francesco Milizia, *Le Vite de' Piu Celebri Architetti d'ogni nazione e d'ogni tempo: precedute di un saggio sopra l'architettura* (Roma: Komarek, 1768), 199.; William B. O'Neal, "Francesco Milizia, 1725–1798" *Journal of the Society of Architectural Historians* 13, 3 (1954): 12–15. Milizia was a prominent and prolific architecture theorist, whose circle of influence included the German painter Anton Raphael Mengs (1728–1779), the Spanish art collector Don José Nicholas De Azara (1730–1804) and the father of modern art history, Johann Wincklemann (1717–1768).; Stefano Ticozzi, *Dizionario degli architetti, scultori, pittori...d'ogni età e d'ogni nazione* (Milano: Gaetano Schiepatti, 1830), 223–24.

[35] Wittkower, *Italian Baroque*, 178. Rudolf Wittkower (1901–1971) states that Guarini's name was virtually unknown when he studied during the 1920s in Munich under Heinrich Wölfflin (1864–1945). Wittkower's recitation of Milizia's words translate as, "Good luck to anyone who likes Guarini's architecture – but count him among the cranks." Meek, *Guarino Guarini*, 1. Meek's translation, in *Guarino Guarini*, 1, reads, "whoever likes Guarini's architecture, much good may it do him, but he would be a nitwit."; Rudolf Wittkower, "Introduzione al Guarini" in *Guarino Guarini e l'Internazionalità del Barocco, Tomo Primo* (Torino: Accademia delle Scienze, 1970), 21. "Il Milizia, naturalmente, scoprì nella sua architettura 'stravagantissime

The art historian Stefano Ticozzi (1762–1836) included an entry on Guarini's work in his 1831 publication *Dizionario di Architetti, Scultori e Pittori*, which also shed a negative light on his reputation:

> because every notion of good taste had been lost in that age...[Various] cities had the misfortune rather than the luck to possess buildings by him....Everything about them is arbitrary, without rule, contrived. He died, to the benefit of art, in 1683.[36]

The scathing condemnation of Guarini's work during the age of Neoclassicism speaks to the advancement of his architecture beyond his own time and into the subsequent age.

Tomasso Sandonnini offers the first close account of Guarini's life in the nineteenth century, based directly on archival and period documents from northern Italy, including the *Archivio dei Teatini dell' Opera Pia*, the *Archivio di Stato di Torino*, as well as manuscripts and codices from the municipality of Modena.[37] Sandonnini's biographical entry, much like many other archival records, was kept on record in Italy. The significance of archival sources such as the *Archivio di Stato* is that it is based on the public record that is taken of any citizen, much like a census but often more personal as well as positive in nature about the individual's life.

The architect and art historian Cornelius Gurlitt wrote a chapter on Guarini in *Geschichte des Barockstiles in Italien* (The History of the Baroque Style in Italy) in 1887, marking what is perhaps one of the first pieces of literature that shed a positive, yet highly

forme… ed ogni spezie di ghiribizzo' e concluse 'a chi piace l'Architettura del Guarini buon pro gli faccia; ma stia tra' pazzarelli.'"

[36] Ibid., 178.

[37] Sandonnini, "Padre Guarino," 482, 490, 496; For the references to Sandonnini in these writings, refer to: Robison, "San Lorenzo," 2, 3, 8; Klaiber, "Theatine Architecture," 14–16; Carboneri, "Modena," 50; Augusta Lange, "Disegni e documenti di Guarino Guarini" in *Guarino Guarini e l'I*nternazionalità del *Barocco, Tomo Primo* (Torino: Accademia delle scienze, 1970), 123; Gianni Carlo Sciolla, "Note sul 'Trattato di Fortificazione' del Guarini" in *Guarino Guarini e l'I*nternazionalità del Barocco*, Tomo Primo* (Torino: Accademia delle scienze, 1970), 513; Mario Passanti, *Nel Mondo Magico di Guarino Guarini* (Torino: Toso, 1963), unpaginated.

critical light on Guarini's work as an architect.[38] Gurlitt felt that it was inadequate to understand Guarini and the architects of the Baroque period in the same way that one conceives of the religious ideas of the Renaissance; that the Baroque school of thought pertained to a different kind of mysticism and that those architects, including Guarini, created important works through the invention of new forms.[39]

The first major set of essays that grapple with the scientific, cosmological basis of Guarini's work was presented in a two-volume set of conference proceedings, published by the *Accademia delle Scienze di Torino*, entitled *Guarino Guarini e l'Internazionalità del Barocco*. The conference included an extensive cohort of some of the most prominent scholars in the field.

Seventy-four essays by seventy-one scholars were presented over the course of six days, with a new subcategory presented each day, including Guarini's architectural works (*Le Opere Architettoniche*), theoretical studies on perspective, geometry and a study of Guarini's treatises (*Guarini Teorico*), sources of influence in Guarini's work (*Le Fonti del Guarini*), interpretations of Guarini's architectural language and cosmology (*Interpretazione del Guarini*), the diffusion of Baroque architecture beyond Turin and Northern Italy (*Guarini e la Diffusione del Barocco*) and Guarini's knowledge of mathematics, philosophy and science (*Guarini Matematico, Filosofo e Scienzato*).

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[38] Cornelius Gurlitt, *Geschichte des Barockstiles in Italien* (Stuttgart: Verlag von Ebert & Seubert, 1887), 447–60. It is notable that the art historian and architect Cornelius Gurlitt (1850–1938) is the father of Hildebrand Gurlitt (1895–56), who was a dealer in Nazi looted art. In 2012, his horded collection was recovered in the apartment of his son, Cornelius Gurlitt II, at the culmination of a joint effort between German authorities and the Federal Bureau of Investigation.

[39] Ibid., 454. "*Die schwere Färbung der verwendeten Marmorsorten, die Sparksamkeit mit dem Gold, das wieder nur am Hauptaltar stärker auftritt, das sinnverwirrende Durcheinander bei unsicherem, nur hoch oben durch die unfertige Kuppel eindringendem Lichte — Alles dies ist höchst bezeichnend für die heit, die übersichtliche Verständigkeit und die heitere Sinnlichkeit der Renaissançe für seine Auffassung der Religiosität nicht genügten, der veilmehr in mystischer Schwüle, in nur mit grübelnder Tüftelei zu erfindendem Formenwuft das Höchste schaffen zu können glaubte.*"

Marcello Fagiolo presented a significant paper entitled "La Geosofia del Guarini." In the first paper, Fagiolo presents a syntagmatic theory for understanding Guarini's architecture in relation to the architect's treatises concerning geometry, philosophy and astronomy.[40] "La Geosofia," sets the groundwork for understanding Guarini's cosmology. The connection that Fagiolo makes between Guarini's architecture and his other disciplines had not been previously explored or systematized. He touches upon various aspects of mathematics, astronomy and philosophy within Guarini's treatises, demonstrating their connection to geometries and their application in building. Fagiolo also describes the Church of San Lorenzo as a massive solar clock, with an 'infinitude' of fenestrations in the design of the lantern, in which three levels of eight windows represent the twenty-four hours of the day.[41]

Fagiolo's 'Geosofia' is significant because it provides the building blocks for understanding the complexity of Guarini's mental process and how it connects to the art of building. However, his article is brief and remains fairly abstract without further corroboration of research. Fagiolo's theory of San Lorenzo as a sundial is sound as it is based on the second principle of Guarini's theory of architecture (*orologia*).

Fagiolo also claims that Guarini believed in the geocentric theory of astronomy. There are two reasons why Fagiolo makes this claim: because of Guarini's Catholic faith, he perceives an illusory bond between geometry and geocentrism and because as a Theatine

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[40] Marcello Fagiolo, "La Geosofia del Guarini" in *Guarino Guarini è l'Internazionalità del Barocco* (Torino: Academia delle Scienze di Torino, 1970), 181. Fagiolo writes that the "name *geosofia* [*sic*] defines the complete intellectual system of Guarini's work."; It is a "chemical-algebraic formula that converges philosophy, astronomy, physics, theology, literature, architecture, engineering and even poetry in the direction of geometry."
[41] Fagiolo, "Geosofia," 189.; John Hendrix, *Architectural Forms and Philosophical Structures* (New York: Peter Lang, 2003), 92–3.

priest, he lived in fear of being charged with formal heresy by trying to defend the theory of heliocentrism.[42]

The first chapter of Guarini's *Caelestis Mathematicae*, supports the theory of heliocentrism, while also expressing its controversy in terms of dogmatic and legal contention:

> Earth at the center of the (celestial) sphere as posited by Ptolemy is today Copernicus' sun; it is of such great contention and a legal matter that disturbs astronomers, that nobody can ignore henceforth since one's credibility is gravely threatened; Copernicus' efforts, tried and tried to eliminate earth as the center. And therefore; we only briefly ask this question, since it has already been brought forth repeatedly.[43]

Guarini's adamant support of the heliocentric theory is clear in this passage, as well as his frustration concerning Copernicus' futile abolishment of the geocentric theory in the sixteenth century.

The idea that Guarini would have adhered to the theory of geocentrism or would have at least made it appear that he did, is well founded because of conflicts within the Church during the late Baroque period involving the Inquisition and the seemingly disparate nature of religion and science. The Roman Inquisition (*Sacra Congregatio Romanae et*

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[42] Fagiolo, "Geosofia," 186. "*Ora, diventa carico di destino il fatto che Guarini, il fanatico della geometria, rimanga ancorato alla teoria geocentrico dell'universo.*" Fagiolo goes on to say that while Guarini was influenced by Galileo and Copernicus, his Theatine theology prevented him from developing a heliocentric theory which would have been considered heretical.; He also restates this on page 187: "*È chiaro che un teologo teatino non poteva condividere una teoria eretica, a rischio di venire espulso dall'ordine e contraddire quello che era ritenuto un dogma di fede; ma è pur sempre singolare contrappasso il legame illusioriamente causale fra geometria e geocentrismo*."

[43] Guarini, *Cælestis*, 22. *Centrum sphæræ Terram Ptolemæus posuit, Solem Copernicus: hodieq; est lis adeo inter Astronomos agitate, ut nemo non ignoret hinc inde probabilitates adductas maximaq; Coperniceorum molimina, quibus a centro terram eliminare satagunt, & conantur. Ideoq; nos breunter ab hac quæstione, utpotè iam decantata, expediemus.*; Copernici, *de Revolutionibus*, 134. "*Hactenus terræ circa Solem, ac Lunæ terram absolvimus revolutiones.*" Theories pertaining to heliocentrism are typically thought to originate with Aristarchus of Samos prior to Copernicus (310–230 BC). However, Guarini specifies in the *Cælestis* that Aristarchus' theory is also corroborated by Pythagoras by measuring the distance of the earth from the moon. Guarini, *Cælestis*, 157. "*Hic modus fuit Aristarchi Samnij, inventus, ut ostenderet Solem remouendem magis a terra, quam sextuplo distantiæ Lunæ, quod Pithagoras affirmabat.*" However, an historical discrepancy seems to exist here, because Pythagoras was born in the sixth century BC (570–495 BC), more than two centuries prior to Aristarchus.

universalis Inquisitionis seu sancti officii) was founded by Pope Paul III (1534–1549) in 1542 in response to the Protestant Reformation and the spread of heterodoxy.

The trial and imprisonment of Galileo Galilei (1564–1642) for his vehement defense of the heliocentric theory was not the only case involving the persecution of astronomers. A number of astronomical texts that supported heliocentrism were put on the list of prohibited books (*Index Librorum Prohibitorum*) by Pope Alexander VII (1599–1667), including Nicolaus Copernicus' *De Revolutionibus Orbis Caelestium* (1641) and three of the most influential works by Johannes Kepler (1571–1630), including *Astronomia Nova* (1609), *Harmonices Mundi* (1619) and *Epitome Astronomiae Copernicae* (1617–1621) the work of authors which are extensively referenced in Guarini's treatises.

Twenty-first century writings on Guarini have brought forth new research on Guarini's life and work which focus on two main subject areas: site-specific history of shorter periods in Guarini's life and studies of Guarini's architecture involving computer-generated geometric analysis. A third area of research has been brought forth by a few major figures in the field of twentieth and early twenty-first century architecture theory whom I have had the privilege to work with in research and publishing.

The school of thought which developed at Cambridge under the auspices of Dalibor Vesely brought about a renewed interest in what may be considered the "architecture of mind." Dalibor based his teaching methods on cultural hermeneutics involving literature of the sixteenth and seventeenth centuries, a time after which representation became divided involving the perception of space within architectural works. The work of architecture is seen through the lens of epistemology as a method of knowledge and through phenomenology as a method of perception within a defined space.

Existentialism developed as a subset of Phenomenology in the works of Jean-Paul Sartre and Maurice Merleau-Ponty, during a century wrought by the most vicious wars ever brought upon humankind, as a method of logic intended to circumvent despair and the non-existence of reality as anything other than what may grasped by what one can perceive.

This school of thought circumvents the presumed role of the twentieth-century professional architect, for the life of a scholar. The role of the architect has become a corporate puppet among puppet masters, whose financial gains are made just as quickly hiring slave labor to raise a building as it is made by razing it, with no concern for humanity, inside or outside the walls which they have built. As many architects have kept building design hidden within their interior life and studio practice, hoping to advance the future of architecture from the historical root of the past.

A prodigious scholar from the Cambridge school by the name of James Patrick McQuillan set a precedent for the avant-garde in his dissertation "Geometry and Light in the Architecture of Guarino Guarini." McQuillan's dissertation is presented in a most hermeneutical manner, which goes beyond a method of literary interpretation and into the depths of philosophical contemplation. McQuillan's dissertation greatly influenced my earlier writings on Guarini as well, since the writing of my master's thesis "Ocularium Lucis: Light and Optical Theory in the Church of San Lorenzo."[44]

John Hendrix is an incredibly prolific author of the history and theory of architecture, as well as an intellectual historian of Italian culture. He has produced a number of works that exhibit a profound theoretical understanding of Baroque architecture, including

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[44] James P. McQuillan, "Geometry and light in the architecture of Guarino Guarini" (Ph.D. Diss., University of Cambridge, 1991), 14. McQuillan also mentions Guarini's association to both Descartes as well as Bullialdus.

the work of Guarino Guarini. His second book *Architectural Forms and Philosophical Structures*, and specifically the chapter entitled “Guarino Guarini and Bernardo Vittone” pertains to the Church of San Lorenzo. Hendrix focuses on Guarini’s relationship to Vittone and the influence of Gottfried Wilhelm Leibniz as well as the idea of cosmology and symbolic number theory. Hendrix’s theoretical understanding of architecture comes out of a very well-learned knowledge of architecture, aesthetics, philosophy and Neoplatonism.

Susan Klaiber has worked diligently to develop an intricate understanding of the architect’s life within the context of early modern European history. Her 1993 dissertation “Guarino Guarini’s Theatine Architecture,” relates Guarini’s work to his education as a seminarian and the structure of the Theatine order. Klaiber has also published a number of articles detailing the various periods of Guarini’s life as well as a chapter in a recently published volume entitled *Guarino Guarini*, co-edited with Giuseppe Dardanello and Henry Millon.

Following the same course of research are many publications that advance the understanding of Guarini’s methods involving engineering and design, including Graziella Fittipaldi’s book, *Spazio, forma e struttura nelle architettura di Guarino Guarini* and several articles by Elwin Robison. However, I believe that the research presented in the work that follows is different in its approach, as I draw primarily from Guarini’s geometry and mathematics to piece together an understanding of his design methods. In contrast, the research conducted by Fittipaldi as well as Marco Boetti, Particia Radelet-de Grave and Amelio Fara among others, tends to theorize about geometries within Guarini’s church by using computer generated graphics and extrapolating upon geometries based on modern sources.

The prescient notion of genius and the advancement of destructive movements in history far too often take precedence over the slow-moving labor of creativity brought to fruition. Several centuries of dragging Guarini through the mud attest to this problem which seems forever recurrent in history.

The aggressive negativity towards Guarini's works in the centuries that follow in his wake seem to increase during times which, on the one hand, are seemingly progressions toward the future, and on the other, are overly critical expressions of arrogance and contempt; as criticality increases, the work behind such incredible projects, both material and intellectual seemingly fall either into idle hands or into the destructive hands of power. Negative criticality can easily overthrow such beauty and light under such circumstances, leaving us blind to anything other than bellicosity.

Guarini's research into the fields of astronomy, physics and biology in the *Placita Philosophica* elaborated upon the earlier lunar theories of Galileo Galilei (1564–1642) as well as other work which predates the work of Isaac Newton (1643–1727), Albert Einstein (1879–1955) and Charles Darwin (1809–1882). The most fascinating part of this rediscovery of knowledge of Guarini's research is that the first aspect of the influence of his architecture in built form relates to the second and is the very premise of *Geometry of the Sun*.

The astronomy presented in Guarini's *Placita Philosophica*, like the *Cælestis Mathematicae*, pertains to the theory of the earth revolving around the sun and the light upon the surface of the earth during the diurnal cycle. This theory involves the creation of sundials and the study of gnomonics which becomes important in the design of San Lorenzo. The knowledge of this which he begins to develop in the *Placita Philosophica* is the beginning of what will ultimately be brought to fruition at San Lorenzo.

Another aspect of astronomy after the setting of the sun is the moon and the nocturnal display of trillions of stars, calculated by the precise astronomical calculations developed later in the *Cælestis*. Galileo gained knowledge of the moon through the use of a telescope (*siquidem obiecta thelescopio*) and the use of mathematics as an instrument of measurement for studying the stars (*oportet nos mathematicos profiteri, & iam instrumenta mensoria prae manibus habere, si tamen caelestes affectiones intimiùs perscrutari volumus*).[45]

Galileo's observations on the movement of the stars and their revolution around the celestial sphere pertain to how their rays of light extend forth (*motuum enim illorum volumina, illius lucis extensionem*).[46] Guarini describes the shadow cast upon the moon as it circumnavigates the earth, and that, like a sundial, can function as a form of gnomonic projection (*luna semper causat umbras alicuius styli maiores; vel remotior oculus noster à stylo, videt lunam vertici gnomonis supereminere immediatè, quàm respiciens solem*).[47]

Guarini concludes that Galileo's observation of the change in lunar distance is due to a change in velocity; that when the moon appears closer to the earth, it moves faster

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[45] Galileo Galilei, *Siderius Nuncius* (Venice: Thomam Baglionam, 1610), 8.; Ibid. Common knowledge of Galileo's lunar observations, is his discovery of craters and mountains on the moon: "*At consimilem penitus aspectum habemus in Terra circa Solem exortum, dum valles nondum lumine perfusas, montes verò illas ex adverso Solis.*"; In another discovery made by Galileo, he detected a variance in the distance of the moon from the earth during its orbit (*verum non modo tenebrarum & luminis confinia in luna inaequalia, ac sinuosa cernuntur*).; Guarini, *Placita*, 308. The same observation, of the variant distance of the moon, as it is written in the *Placita*: "*…conspecta viciniora augentur magis, quà remotiora*."
[46] Ibid.
[47] Ibid., 308.

(*quia quantò magis aliquid oculis nostris vicinum est, tantum velociùs apparet*).[48] Guarini attempts to discover the reason for this, using Euclidean geometry, triangulation and *quadratura* (quadrature), the available methods at a time that still, ever so slightly predate the development of the Calculus and the theory of universal gravitation by Isaac Newton (1642–1726).[49]

The lunar observations of Galileo and Guarini predate Newton's Theory of Universal Gravitation by only about a decade. However, several other scientific claims made by Guarini and his close contemporaries predate a number of other important discoveries. Prior to the publication of Newton's *Principia*, Guarini theorizes that the velocity of light is a constant and the movement of light is a perturbance or wave.

Eleven years after the publication of the *Placita*, the Danish astronomer, Ole Christiansen Rømer (1644–1710), along with Jean Picard (1620–1682) and Giovanni Domenico Cassini (1625–1712) also made observations that light travels at a constant velocity and made an approximation of its speed by comparing the propagation of light from Jupiter, when the earth is at two different distances from it.[50] Cassini quantified Rømer's findings,

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[48] Ibid.

[49] Guarini, *Placita*, 308. "*Quando igitur ab horizonte Luna faltem 8. gradibus elevata est, collocant Astrologi quadrantem Geometricum qui à longè altitudines mensurat: collocant, inquam, brachio stabili parallelo ab horizontem, se ad Libellam, & mobile elevant ad ipsam Lunam; ita ut radius Transeat per duo piniccidia a vel foramina illius: & in quadrante numerant gradus, incipiendo à lineâ perpencidulari ad brachium stabile, quì tot erunt, quot intercludutor inter lineam AB & lineam CD.*" Quadrature, which was a method of determing area, was one of the major mathematical advancements that led to the creation of the Calculus.; Isaac Newton, *Philosophiae Naturalis Principia Mathematica* (London: Josephi Streater, 1687), 4. "*Hasce virium quantitates brevitates gratia nominare licet vires absolutas, acceleratrices & motrices, & distinctionis gratia referre ad corpora, ad corporum loca, & ad centrum virium: Nimirum vin motricem ad corpus, tanquam conatum & propsensionem totius in centrum, ex propensionibus omnium partium compositum; & vim acceleratricem ad locum corporis, tanquam efficiciam quandam, de centro per loca singula in circuitu diffusam, ad centrum, tanquam causa aliqua præditum, sine qua vires motrices non propagantur per regiones in circuitu; sive causa illa sit corpus aliquod centrale (quale est Magnes in centro vis Magneticæ vel Terra in centro vis gravitantis) sive alia aliqua quæ non apparet.*"

[50] Laurence Bobis and James Lequeux, "Cassini, Rømer and the Velocity of Light." *Journal of Astronomical History and Heritage* 11, 2 (2008): 97.

stating that the velocity of light is “more than 600,000 times greater than that of sound.”[51] Rømer and Cassini presented their findings to the French Academy of Sciences seven years later in 1683.[52]

Guarini also theorized that light travels from the sun to the earth in a vacuum (*coniuncta soli est: unde vacua luce*) until it reaches the atmosphere creating heat, wind and the movement of the ocean; a concept that would not be developed further until Albert Einstein (1879–1955) and the Theory of General Relativity.[53]

Book Six of the *Placita,* “Disputatio IV, The Life of the Spirit” (*De Spiritibus Viventium*) begins by defining spirit and whether or not the spirit may be found in all living things. He makes a distinction between plants and animals, stating that while many plants have a medicinal effect on the body of an animal or human, the spirit which he describes is something that is more clearly present within blood (*ex sanguine diversa promanant; qui spirituosae substantiae*).[54]

Disputatio V, On the Generation of Life (*De Viventium Generatione*) discusses procreation and the propagation of species and genera of various *animalium*. The disputation begins, like Adam calling the animals by name, pointing to the multitude of animals upon

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[51] Ibid., 100.
[52] Marin, Gabriel, Jean-Baptiste Coignard and Hyppolyte-Louis Guerin, *Table Alphebetique des Matieres Contenues Dans l’Histoire & les Memoires de l’Académie Royale des Sciences, publiée par son Ordre*. *Tome Premier, Anne’es 1666–1698* (Paris, France: Par la Compagnie des Libraires, 1734), 313.; Bobis and Lequeux, “Velocity of Light,” 98.
[53] Ibid.; Albert Einstein, *Relativity: The Special and the General Theory* (London, England: Methuen and Co. Ltd., 1920), 36–7….[calculate here how Guarini arrived at the equation of 600,000 times the speed of sound, and how that compares to Einstein’s calculation of 186,000,000 miles per second. However, it would be necessary to determine what method Guarini is using to calculate the speed of sound, prior to determining how close his calculation is to Einstein’s, as these methods were different in Guarini’s time.]; Ibid., 504. See Expesio IX, *De Motibus Maris*.; Vesely, *Divided Representation*, 203. “Visible light and the luminosity of things are only manifestations, or in Guarini’s own words ‘modifications,’ of light; these modifications include extension, intensity, reflection, refraction, and its fast and slow motion, particularly its velocity.”
[54] Ibid., 538.

the earth and the fish within the sea (*terras unius species non esse, sicut nec aquas; sed multas species à principio Deum tum terris, tum aquis indidisse*).[55]

He continues by stating that living creatures possess a hidden potential and that the beauty of their creation pertains less to coincidence (*accidens*) and more to do with this hidden internal power (*potentias occultas in rebus posse servari: & licèt minùs nobiles quoad suorum accidentium exhibitionem, posse tamen potentiam servare internam*).[56] He defends this argument with the Bible and with the *Hexameron* (Six Days of Creation) of Saint Ambrose who states that God's creation is imparted according to the law of nature which the earth as a vessel endures, bringing forth the future of existence (*Dei singulis creaturis gignendis impertita, naturae lex est, quae terris in aenum permansit futura successionis datura praescriptum*).[57] The spirit created by the flow of blood through the body (*spirutus in corpore*) the organs (*organorum*), muscles and membranes (*musculus enim, ut trahat membrum*) the nervous system (*nervos*) and the optic nerve (*nervis opticis*) causes the creation of heat within animals and humans as well.[58]

[55] Gryson, ed. *Biblia Sacra*, 6. (Genesis, 2:19–20). "*formatis igitur Dominus Deus de humo cunctis animantibus terrae et universis volatilibus caeli adduxit ea ad Adam ut videret quid vocaret ea omne enim quod vocavit Adam animae viventis ipsum est nomen eius appellavitque Adam nominibus suis cuncta animantia.*"; Guarini, *Placita*, 643.
[56] Ibid.; Marsilio Ficino, *All Things Natural: Ficino on Plato's Timaeus*, trans. Arthur Farndell (London: Shepheard-Walwyn Publishers, Ltd., 2010), 28. In comparison, Ficino provides another theory involving generation and corruption and the evolution of forms in nature in his commentary on the *Timaeus*. "Within the world we see not only a differentiation of forms, but also a state of opposition; for the world comes forth from the First, and as it comes forth it declines. Indeed, the outward movement causes differentiation, and the decline causes opposition. The fact is that the origin of the division is the fecundity of the cause, overflowing on all sides and spreading far and wide; but as the division moves forward in many steps, it eventually reaches the state of opposition, especially since the material of the world is unable, on account of its own weakness, to reconcile the forms in the way that the higher world reconciles them with itself. Thus it came that God spread forth matter and measured it out in order to collect, at various resting points, forms which are likely to be mutually opposed…the opposing qualities and forms of the heavens are conducive to the daily begetting of new forms through the variation of movement."
[57] Ibid.
[58] Ibid., 639.

Guarini's argument for evolution is biological, as it is in Darwin's *Origin of Species*, involving the study of various species, the effect of the environment in which they live and how they interact.[59] He writes on the transmutation of species and that this movement in nature, this alteration, may be caused by bifurcations within the *materia prima* as it is guided by this hidden potential.[60] However, differently than Darwinian evolution, Guarini's theory is not based on competition but rather the transmutation of this primary element, the hidden potential of nature.

"Disputatio VI, De Altrici et Auctrici Facultate" (*On the Faculties that Nourish Life*) begins by discussing the aspect of heat (*calorem vitalis*) within the lifeblood of living organisms. He theorizes that the heat within living bodies may descend from the heavens and from the light of the burning sun (*si calor vitalis in animalibus à calore caelesti descenderet*) or that it may be produced of its own accord, by the arterial pulsation of the body (*calor vitalis ex pulsatione cordis arteriarumque in ipso corpore enascitur*).[61]

Within all of these theories there is prescient and fleeting advancement; an advancement which may have been withheld for a short time during the Inquisition of Pope Alexander VIII to be rediscovered during the mid-to-late period of Enlightenment in the century that followed.

[59] Charles Darwin, *The Origin of Species* (New York: P.F. Collier & Son, 1909), 58–62.
[60] Guarini, *Placita*, 652.
[61] Ibid., 672.

Relevance for the Contemporary Reader

Contemporary readers of the twenty-first century can find a wealth of knowledge in Guarini that spans the full spectrum of architectural interest from those interested in philosophy to construction technology in the most progressive sense. What is most fascinating perhaps in Guarini's work is the way he facilitates the most arcane and abstract philosophies in ways which directly connect to fundamental problems in building. Guarini's life, like the parabolic and hyperbolic forms of San Lorenzo is a passage through time and a precedent for the future.

San Lorenzo was being constructed in 1666 while the world swiftly headed out of the Baroque and into the era of Enlightenment that followed. However, the era that followed seemed to mark a division between creativity and knowledge, imagination and logic, which posited a new understanding of science through domination and control of the external world. The advent of architectural modernism has many times been compared to the Baroque period as a second intersection between nature and humankind which came thereafter, renewing and vilifying existence from the world's darkest moments.[62]

The contemporary architect may experience a resistance in relating to Guarini's architecture because it is old or too religious, especially from the vantage point of the twenty-first century. The twentieth-century relationship to religion, given the current world

[62] Kenneth Frampton, *Modern Architecture: A Critical History* (London: Thames and Hudson, 1980), 187. Frank Lloyd Wright (1867–1959) brought about an innovative use of prismatic glass in building, which echoes the Guarinian use of multidimensional of light as form. His use of light emerged toward a cultural idea he called *Usonia*, which also echoes Guarini's symbolism involving the harmonious relationship between *las tres culturas*.

regime, plunges the golden warmth of the Renaissance sun into the darkest waters of night. Untold violence in North Africa and the Middle East since the beginning of the twenty-first century is not much less than another World War One that has spread like wildfire into Europe and the Americas, advancing genocide toward the ancient religions of the west in a similar attempt to repeat the historical events of the last century.

Corporate-backed contemporary architects are swiftly advancing like twenty-first century futurists through what has been in many ways similar to another Cold War era.[63] While the constructive fabrications of these architects create a sleek illusion of virtual existence, the dark side of this endeavor furthers the aggressive overtaking of human life. What the politically correct refer to as gentrification, the poor of the urban ghetto experience as destruction and perestroika.[64]

The influence of Guarini may prove beneficial to the mind of the contemporary architect if one can sift through the illusion created by corporate virtual futurism and return to an idea of architecture at the center of one's idea of existence. If the contemporary architect can overcome the illusion of perspective as an idea and return to the creation of

[63] Natalia de Val Navares, "La Virtualidad de Fantasmática del Límite: Geometría y Dematerialización en la Arquitectura de Museos de Jean Nouvel" in *AC—Research* 2, 140 (2015): 210–11. "*Es la condensación de modernidad y tradición, de Oriente y Occidente, puesto que el cojunto de estos mecanismos cuadrados evoca a un gran mosaico de* moucharabieh *mientras que su tecnica remite a la precision de la maquinaria de los relojes suizos o a las diafragmas de la cámeras fotográficas*."

[64] Perestroika (*перестройка*) , *lit*. 'Paramilitary Strike.' The term was used during the first Cold War (1947–1991) by Mikael Gorbachev to represent a form of social terror and control which he considered 'restructuring.' Perestroika included terror strikes to urban apartments, especially in places like Belgrade and Chechnya. This was used as a form of violent upheaval, along with an economic component known as Glasnov, which took back food and money from the poor while appearing like a social form of economic stimulus. These two concepts are in many ways comparable to strikes on inner-city property such as project buildings. Perestroika attacks can be because the lien was not met by people on welfare, while Glasnov takes more money from those on it through taxation or other economic reforms. Perestroika and Glasnov work along with media-driven influences which fuel violence and social conflict known in Russia as active measures (*активные мероприяти*).

space to create ethical, emotional and spiritual depth, architecture can successfully awaken the harmony of the soul as it resides in a universe intertwined with beauty and nature.[65]

From a religious standpoint, Guarini represents the vestiges of the golden era of the Renaissance at the end of the seventeenth century. The fleeting existence of time brought about by an increase of universal knowledge unfortunately provided a political catalyst for those who sought power to control and to dominate. Guarini's knowledge as a creative genius were wrought in the hands of the powerful in the Church, leading not to an inquisitive exploration, but to the Inquisition in fear of exploration and the love of knowledge. The creation of life is stifled; the pragmatic is used as a means to an end. The modern religious mind can no longer separate energy which creates from that which destroys, or the light of the sun which warms the soul from fire that burns.

The scientific advancements that Guarini presented to the world in the seventeenth century, and had their culminating effect in the twentieth century, are still problems as well as advancements that humankind is grappling with a century later. In terms of architecture, the struggles that taint religion in the contemporary mind may be overcome by relating these advancements toward a creative new vision of an avant-garde, allowing humanity to lift ourselves out of the depths of cold-war mentality and to put into question what is new and what is old in the realms of both religion and science.

[65] Nicholas Temple, *Disclosing Horizons: Architecture, Perspective and Redemptive Space* (London and New York: Routledge Press, 2007), 161. "What Temple refers to as 'redemptive space' is paramount to the idea that the *axis mundi* is not merely a geographic *locus*, but a home and the center of one's existence.

PROEMIA

Fulcrum and Asymptote

Guarino Guarini (1624–1683) was an architect, priest and polymath. He was the designer of seventeen buildings and the author of ten volumes which span the fields of architecture, mathematics, astronomy and philosophy. The complexity of knowledge presented in his treatises are present in the design and structural framework of all his buildings; they comprise the foundation of his theory of architecture, a unified system of compound philosophical, mathematical and astronomical knowledge that he applies directly to the design of his buildings at a high level of intricacy.

The foremost desire of humankind is to find ourselves within the universe. By locating where we are, we discover more about who we are. For Guarini, the sun is the *lux orientis*. As he states in the *Caelestis Mathematicae*, we are but a piece of barley, orbiting without cease, within the bedroom chamber of the sun.[1]

The fundamental importance in the architect's design for the Church of San Lorenzo is to create a kind of instrument which provides a direct, experiential connection to

[1] Guarino Guarini, *Cælestis Mathematicae, Pars Secunda* (Mediolani: ex Typographia Ludovici Montiæ, 1683), 3.; Orsanmichele…; Secendum Mattheum, 3:12. "*Cuius ventilabrum in manu sua et perminunandabit aeream suam et congregabit triticum suum in horeum peleas autem conburet igni inextinguibili*."

the universe. He accomplishes this by creating a theory of architecture based on three principles which he reinvents, based on Vitruvius' *Ten Books on Architecture* (*De Architectura Libri Decem*): "the art of building, the art of horology and gnomonics (timekeeping and the construction of sundials), and mechanics (the movement and equilibrium of physical bodies)."

At the helm of these three principles is the *axis mundi*; a center-point or fulcrum around which the earth revolves (*axis mundi est dimetiens, circum quem versatur*) toward the principle of the infinite, known as the asymptote (*asymptotos*).[2] The importance in creating an *axis mundi* through the center of the dome is part of his desire to create the effect of standing within an intricate solar, lunar and astronomical calendar while inside the church itself.

Without the knowledge contained in the *Architettura Civile*, the other nine treatises published during the architect's life seemingly provide us with the pieces of a Daedelean puzzle. While the pieces of this puzzle are potentially applicable to any of Guarini's architectural works, I have chosen the Royal Church of San Lorenzo in Turin as the subject of this treatise as it may serve as a paragon that best embodies the specific theory which follows.

[2] The term *axis mundi* is used extensively throughout Guarini's treatises, as well as several other synonymous terms that pertain to the idea of the center of the celestial sphere, including *polo mundum, centrum* Guarino Guarini, *Placita Philosophica* (…), .; Guarino Guarini, *Compendio della Sfera Celeste* (…), .; Guarino Guarini, *Cœlestis Mathematicae, Pars Prima* (Mediolani: ex Typographia Ludovici Montiæ, 1683), 3. "*Linea verò polos coniungens ED mente deducta dicitur Axis Mundi.*"; Vitruvius, *De Architectura* (Strasbourg: Ex Officina Knoblochiana, Per Georgium Machaeropieum, 1550), 406.; Luis Fernández-Galiano, *Fire and Memory: On Architecture and Energy*, trans. Gina Cariño (Cambridge, MA: MIT Press, 2000), 32. "In the prologue of his eighth book, Vitruvius writes that 'the sun and the fire, meant to be fostered naturally, make life more secure.' If the examples cited are convincing, then to the Roman's narrow interpretation of *utilitas* we would have to add that the sun and fire *also* make life more significant. In this way we would better understand the double role—functional and symbolic—played by sun and fire, the world of orbits and that of combustion, celestial mechanics and terrestrial thermodynamics, which constitutes the axis of the relation between architecture and energy."

1.
View of the dome from the sanctuary floor, Church of San Lorenzo, Turin
Photograph by author, 2018

Guarini's design of the Church of San Lorenzo connects the building to the sun by extending the *axis mundi* through the center of the foundation through the lantern and towards the heavens. The interlaced stone catenaries of the dome resemble the ribs of a gothic church or the interior of a mosque, as well the framework of a complex cartographic tool known as a spherical astrolabe or celestial sphere (*sphoera caelestis*).

The importance of the *axis mundi* may be clarified by way of definition and etymology. Disputatio XI of Guarini's *Placita Philosophica*, On Location and Void (*De Loco, et Vacuo*) describes the physical establishment of the *axis mundi* in relation to the celestial sphere, in which "every fixed distance in space may be a location: but nonetheless, the *Polo* (*axis mundi*) is a fixed point, and just as time chooses how the heavens move...."[3] However the semantics of Guarini's language requires a careful examination; translating *loco et vacuo*, as "location and void," fails to convey the complex meaning of these two terms, which become clearer when considered epistemologically within the context of Guarini's theory of architecture.

While *loco* may be defined as 'location,' or "to put something in its proper place," an example of this term is given by extension: "*loco ipsa (mater) arcum pharetrasque*." The phrase was written by the Roman poet Publius Papinius Statius (c. 45–96 AD) and is from the *Achilleid* (94–95 AD), an epic poem about the life of Achilles, and translates as "the location of matter itself, as the arrow that extends in form of a quiver."

A closer look at Statius' prose reveals why this reference relates back to our original term: *arcum*, is defined as a bow for shooting arrows. *Pharetrasque* is the quiver of the arrow, but by extension, may also be defined as a sundial in the form of a quiver. Therefore, the dial (*pharetra*) is the quiver; the bow and its arrow (*arcus*) are the gnomon.

Apollonius of Perga (c. 240–c. 190 BC), a mathematician and astronomer extensively referenced in Guarini's treatises, is often credited with the invention of a type of sundial which Vitruvius refers to as the "*Apollonius pharetram*."[4] Apollonius' treatise on

[3] Guarini, *Placita Philosophica* (Paris, 1655), 274. "*Nota tamen, omnem distantiam fixam posse deservire pro formalitate loci: sumitur tamen, à Polo, sicut tempus desumitur à motu cœli, tanquam à puncto fixo, & magis omnibus noto.*"

[4] P.G.W. Glare ed., *Oxford Latin Dictionary* (Oxford: Oxford University Press, 1982), 1038, 164, 1372.; Sharon L. Gibbs, *Greek and Roman Sundials* (New Haven and London: Yale University Press, 1976), 60–1. "Many commentators on Vitruvius's list have suggested that the terms *arachnen* and *conarachnen* refer to the network of hour lines and day curves on a dial face rather than to a particular type of shadow-receiving surface. *Arachnen* derives from the Greek *αραχνη*, meaning "spider's web," and seems an appropriately descriptive term. The suggestion that the terms refer to some sort of metal fretwork has not, to my knowledge, been supported by archaeological evidence. The inventor has been identified as Eudoxos of Knidos, the mathematician and astronomer who flourished about 370 B.C. He is the earliest inventor mentioned by Vitriuvius, and the singularly high quality of his mathematical works makes it plausible that he made basic contributions also to the theory of dialling. The *arachnen* is alternatively atributed to Apollonius [*sic*] who wrote

Conics is extremely important in Guarini's knowledge as a mathematician and its application to his architectural design, which he applies to many facets of the design of San Lorenzo.

The word which Guarini uses to define void (*vacuo*), is defined in the *Oxford Latin Dictionary* as "something that is empty" or "has semblance without reality, illusory." A contextual phrase is also given: "*vacuo a habendi simulacra*," which comes from Lucius Annaeus Seneca's (4 BC–65 AD) *De Beneficiis*, with *simulacra* being defined as an "image produced by a reflection," "a ghost, or a phantom."[5]

The universal principle of the *axis mundi* and its relation to the asymptote rests on a peculiar logic—a limit which defines a boundary which does not exist; that of the infinitude of space, which maintains a limit that only defines itself by the very nature of its definition and because the symbolic occurrence of the *axis mundi* places infinite space within that boundary, that *locus*.

The *axis mundi* is the center point, the fulcrum around which a building is constructed, because the earth upon which the structure sits is also rotating on its own axis. As the earth makes its diurnal rotation on its own axis, the sun from the position of the earth, appears to circumnavigate the earth. From the building's position on the earth, the sun shifts throughout the day. This is the study of horology, or timekeeping, which is accomplished with the sundial as an instrument.

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the great treatise on conic sections. He is also credited with the invention of a type of sundial called *pharetra*, "quiver."; Vitruvius, *De Architectura*, 320. "*Apollonius pharetram, aliáq; genera, & qui suprascripti sunt, alij plures reliquerunt: ex quorum libris, si quis velit subiectiones invenire, poterit, dummodo sciat anallematum descriptiones.*";

[5] Glare ed., *Oxford Latin Dictionary*, 2001, 1766.

A sundial is constructed of a flat plate called a dial and a gnomon, which is a vertical edge or arrow that casts a shadow upon the plate that is delineated by hour lines. According to Guarini's three principles of architecture, he is connecting the art of building (*edificare*), to the movement of the sun (*orologia*, *gnomonica*), by designing a structure that aligns to a highly intricate, mechanical understanding of the universe in motion (*macchinaria*).

Sundials have been used as an architectural element in the Roman Empire since ancient times. The Roman Pantheon, Santa Maria Novella in Florence, Trinità dei Monti in Rome and the Cathedral of San Giovanni in Turin are buildings that have sundials either within them or on their exterior facades. The Pantheon is designed to bring light through an oculus in the ceiling, so that the path of the sun can be traced by incremental degrees throughout the year. The use of an exterior sundial provides a knowledge of time and season without an oculus within the dome of a church, which is useful for measuring the days of the year and the liturgical calendar.

Guarini's education at the Seminary of San Silvestro included the reading of ancient Roman sources such as Statius and Seneca; sources that were influential in the development of his knowledge of Roman sundials. Guarini's choice of words reveals something contextually important about the meaning of Disputatio XI and the *Placita Philosophica* in relation to gnomonics, the second principle in Guarini's theory of architecture.

The most important point of orientation for the Catholic world is the church. The practice of situating the church *ad orientem*, with the altar toward the east developed in the eighth century, symbolizing the coming of Christ with the rising of the sun. The synonymity of Christ and the sun is as ancient as Christianity itself; Christ depicted as Helios in the tomb of the Julii in the Vatican Necropolis below Saint Peter's Basilica is one example among many.

Symbolic orientation exists in the Gothic church as well. Entering through the narthex represents the passage into the Virgin's womb, the flying buttresses representing her ribs. The cruciform ichnography of the church is transposed upon this structure, so that the cross is transfixed upon the body of Mary; the altar at the transept represents her heart, the place where the Eucharist is held above the chalice, like a disc of light representing the sun.[6]

The symbolism of Christ's body and the sun is also represented in the Chapel of the Holy Shroud, another monumental work commissioned by the Savoy Dynasty in Turin. The Chapel of the Holy Shroud is connected to Turin Cathedral by stairs that wrap around the altar that lead to the upper room, where the shroud (*Sindone*) is kept in a reliquary in the center of the rotunda. Looking upward, there is what seems to be more of a solar chamber than a dome, that leads to the symbol of the sun, with the dove of the Holy Spirit at the center.

Architecture as a form of cosmological orientation exists in a vast number of the world's cultures. In Judaism, it is the Foundation Stone; in Islam, the Dome of the Rock; in Buddhism, the *cakravāla*; for the Siberian Yaküt, there is the Yurt and the cosmic pillar; for the Diné, the center of the world is represented by the Hogan. While the intricate complexities of each culture are diverse, these places of worship represent an *axis mundi* of

[6] Vesely, *Divided Representation*, 200. "The Christian interpretation of the sun as Dies Solis or Sol Invictus gained new force in the seventeenth century, when, supported by the spread of heliocentrism, solar symbolism penetrated all domains of Baroque culture."

each civilization—the center and foundation of the world in a way that is unique to each culture.[7]

Architectural cosmology, the practice of connecting and aligning a building to the universe, is the most ancient and primordial form of design. Guarini writes about the indigenous architects of the Americas in the *Architettura Civile*, stating that their genius as builders was "born from necessity, and their necessity was to find their center." Guarini states that while the practical purpose of building is for geographic orientation, for defense

[7] There are numerous examples of the universal concept of the 'center of the world' or *axis mundi*, particularly in religious texts, the history of religions, as well as anthropology. Examples of this idea in the Christian tradition include: *Stat crux tum volvitur orbis* (The cross is steady while the world turns), the motto of the Carthusian Order, established by Saint Bruno in 932 AD; *The Holy Bible, Douay-Rheims Version* (Charlotte, NC: Saint Benedict Press, 2009), Exodus, 19:23. "Set limits around the mount and sanctify it."; Kings 6:16. "And he built up twenty cubits with boards of cedar at the hinder part of the temple, from the floor to the top: and made the inner house of the oracle to be the holy of holies."; Ibid., 6:19. "And he made the oracle in the midst of the house, in the inner part, to set there the ark of the covenant of the Lord."; M.A.S. Abdel Haleem, trans., *The Qur'an* (Oxford, Eng.: Oxford University Press, 2004), 15. "We made the House [*Ka'ba*] a resort and sanctuary for people, ways, 'Take the spot where Abraham stood as your place of prayer.'"; Mircea Eliade, *Shamanism, Archaic Techniques of Ecstacy*, trans. Willard R. Trask (New York: Bollingen Foundation, 1964), 120. "…even where an initiation of this type is not known, we find shamanic rituals of ascent into the sky that depend on similar conceptions…the birch symbolizes the Cosmic Tree or the Axis of the World, and that it is therefore conceived as occupying the Center of the World; by climbing it, the shaman undertakes an ecstatic journey to the Center."; 169. "The meaning of this symbolism seems sufficiently apparent from the complex of which it is a part: communication between the sky and earth by means of the World Tree, that is, by the Axis that passes through the "Center of the World."; 265. "On the macrocosmic plan this communication is figures by the Axis (Tree, Mountain, Pillar, etc.); on the microcosmic plan it is signified by the central pillar of the house or the upper opening of the tent—which means that *every human habitation is projected to the 'Center of the World,'* or that every altar tent, or house makes possible a break-through in plane and hence ascent to the sky."; 404. "The sacrificial post is an *axis mundi,* and just as the archaic peoples dispatched sacrifices to heaven through the smoke hold or central post of their house, so the Vedic *yupa* was an 'accomplisher of the sacrifice.'"; 430. "The Buddha descends from the Trayastrimsa Heaven by a stairway to 'tread the human path'; from the top of the stairway all the Brahmalokas are visible above and the depths of hell below, for it is a true *axis mundi*, set at the 'Center of the Universe.'"; 447. "As among Tibetans, communication betweeen earth, heaven, and hell takes place along a vertical axis, the *axis mundi*."; 492. "All these symbolic images of the connection between heaven and earth are merely variants of the World Tree or the *axis mundi*."; Mircea Eliade, *The Forge and the Crucible, The Origins and Structures of Alchemy* (Chicago and London: The University of Chicago Press, 1962), 39. "We are in the presence of a very complex symbolism which cannot be reduced to a single plane of reference. For, on one hand, the *vedi* was compared to the navel (*nabhi*) of the Earth, the symbol *par excellence* of the 'centre'."

or proximity to natural resources, it is concomitant with our human presence in the world, to religion and the idea of the cosmos.[8]

This form of orientation that exists in these cultures as the *axis mundi* is an archetype. The *axis mundi* establishes a symbolic center point which delineates between the intrinsic and extrinsic definitions of space, location and movement. The geospatial, cosmographic positioning of the *axis mundi*, while often connected to the meaning of the symbolic and the theological, is another matter entirely.

The celestial sphere is a kind of star map that is comprised of eight intersecting circles which form a sphere, including the equator, the zodiac, the horizon, the meridian and the two tropics. The celestial pole points upward to the zenith and downward to the nadir. Because the zenith is directly 'above' the gravitational force which causes the earth to spin on its axis, the direction of the celestial pole is the point around which the stars of the night sky appear to rotate.

San Lorenzo's dome is constructed of eight intersecting catenaries which resemble the celestial sphere, as if one is looking skyward toward the zenith. The movement of the sun during the day and the spinning of the stars in the night sky is something that can be experienced from within the church.

[8] Guarini, *Civile*, 11–12. "*Ciò dichiarasi e sinceramente perché l'Arte del fabbrichare è nata dalla necessità, ed it bisogno fu il primo che la ritrovò; onde anche I popoli più barbari dell'America ebbero qualche sorta di case, ove ripararsi dalle inguirie de' tempi; dunque il primo scopo degli uomini nel fabbricare fu sovvenire al loro bisogno, e ritrovare negli edifizi loro il proprio comodo. Onde Vitruvio, lib I, cap. 3, afferma che si deve aver riguardo dal prudente architetto alla utilità, dicendo: "Utilitas est ratio, emendata, et sine impeditione usu locorum disposition, et ad regiones, sui cuiusque generis apta, et comoda distribution." E quindi si deducono le seguenti osservazioni*.; He disagrees that native people created architecture as simple or 'barbaric' (*i popoli più barbari*); that it would be insulting to think that they created architecture merely to provide a form of shelter. He fortifies this idea of the native world by quoting from Vitruvius' *De Architectura*: "Reason is born from necessity. It aligns what is truly necessary, and does not impede the use of direction and location to the regions of each of its proper origins."

The celestial sphere was used for cartographic purposes during the age of early-modern globalization and facilitated the voyages of maritime empires in the sixteenth and seventeenth century by aligning terrestrial coordinates with the movement of the sun and the stars.[9] The invention of the astrolabe by Apollonius of Perga (c. 240–c. 190 BC) was rediscovered by Arabic scientists in the tenth century at a time in which Catholic and Mozarabic architecture developed the use of complex systems of vaulting, which Guarini uses in the dome of San Lorenzo.[10]

The invention of a star map known as a spherical astrolabe is accredited to the Greek mathematician Eratosthenes (276–194 BC). This model of the universe is still used today in mapping out star constellations and geospatial coordinates in the study of modern astronomy. Eratosthenes was the inventor of many instruments, one of which created a practical tool for the problem of doubling the cube, known as the *mesolabio*. Doubling the cube is a problem that was intially solved by Archytas (428–347 BC) and is related to squaring the circle, because it pertains to the multiplication of circular or spherical forms. Doubling the cube works as the inverse of that equation.[11]

Two tools designed by Archytas are presented in Daniele Barbaro's translation and commentary of Vitruvius' *De Architectura* from 1567: one which is vestigial (used for

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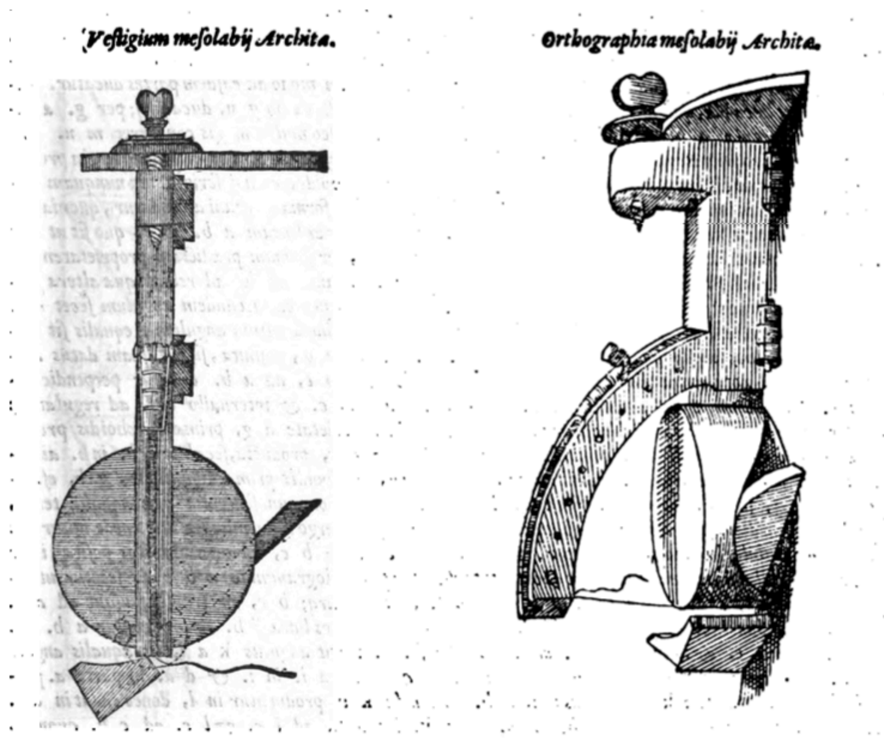
[9] For more research pertaining to the history of spherical geometry, triangulation and its association to solar and celestial mechanics, see: Menelai, *Sphaericorum*, *Libri III* (Oxford, Eng.: Sumptibus Academicis, 1758), ; Gebri Arabis, *Philosophi ac Alchimistae Acutissimi* (Strasbourg: Lazari Zetzneri, 1598), 18.; Francisci Maurolyci, *Theoremata Lumine; Diaphanorum Partes, Seu.; Problemata ad Perspectivam* (Lyon: Apud Bartholomæum Vincentium, 1563), 60. "*Radij verô intra sphæram transperentem à centro àeqè remoti, qui paralleli non sunt, ad idem utrinque signum cum sphæræ diametro à fractionum terminis æquidistanti concurrent…*"; Nicolai Copernici, *Torinensis de Revolutionibus Orbium Cœlestium, Libri VI* (Basel, Switzerland: Henric Petrina, 1543), 24; Ioannes de Monteregio, *Tabulæ Directionum Profectionum* (Vvitenbergae: Matthæi Vellack, 1584), 108.

[10] Adolfo Florensa, "Guarini ed il Mondo Islamico," in *Guarino Guarini e l'Internazionalità del Barocco, Tomo Primo* (Torino, Italy: Accademia delle Scienze, 1970), 639.

[11] Vitruvius, *De Architectura*, 271. "*Itaque Architas hemicylindrorum descriptionibus, Eratosthenes organica Mesolabi ratione idem explicauerunt.*"

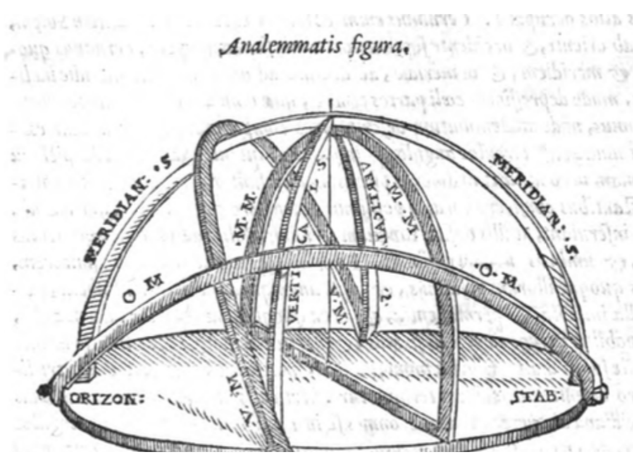
tracing), and the other which is specifically intended for orthographic projection (the re-presentation of three-dimensions on a two-dimensional surface).[12] The tool allows for the production of points and lines within an arcuate system, simultaneously generated from both horizontal and vertical positions (*duos rectos angulos unum*). Lines are extended into hemicylindrical planes to create an infinitely expanding perimeter (*abscindet in eius circunductu eam superficiem hemicylindri & in ea quandam lineam describet*).[13]



2.
Vestigial and Orthographic Mesolabios, from Daniele Barbaro's *De Architectura* (1567)

[12] This publication, along with the subsequent edition made in 1649, provides a clear picture of Guarini's source material. Barbaro's prominence as a commentator and translator of Vitruvius would have still been a primary source of information for Guarini in the mid-seventeenth century. ; Branko Mitrović, "Paduan Aristotelianism and Daniele Barbaro's Commentary on Vitruvius *De Architectura*," *The Sixteenth Century Journal* 29, 3 (1988): 667.
[13] Vitruvius, *De Architectura*, 274.

According to Barbaro's commentary, the extension of hemicylindrical lines forms a conchoid. The Greek mathematician Nichodemes (c. 280–210 BC) studied the geometrical intricacies of the conchoid. His research became particularly important in the seventeenth century because the geomerical solutions found in his mathematics could be effectively applied to architecture. As with the *mesolabio*, the geometry of the conchoid pertains to cube duplication. The curve created by a conchoid is also an asymptote, which allows the infinite sense of expansion within an architectural space.



3.
Diagram of an Analemma, *De Architectura* (1567)

The practical significance of the *mesolabio* in Vitruvius' treatise is the design and construction of complex vaults and domes, composed of intersecting cylindrical volumes, such as those described in Guarini's *Architettura Civile* and found in the Church of San Lorenzo. Barbaro's description of the *mesolabio* applies the use of orthographic projection in connection with the art of stonecutting known as stereotomy. The theoretical purpose of the *mesolabio* in the design of domes facilitates their alignment with the movement of the earth around the sun as well as other heavenly bodies.

The complex intersection of vaults in San Lorenzo's dome resemble the form of the *mesolabio* and the *analemma*, ancient mathematical instruments developed by Eratosthenes and Archytas. Guarini's design for San Lorenzo's closely resembles the Vitruvian model of the hemispherical astrolabe as a model for the dome. The inner structures and fenestrations of the dome resemble what is known as the *rete*, a complex network, or "net," that is placed over the plates and the *mater*, which aid in the location of stars according to altitude, azimuth, and other coordinates.

While the cosmological basis of Guarini's San Lorenzo appears to be based on Greek mathematics, it is equally important to consider the development of technology that has allowed builders to create such monumental works of architecture. One aspect of this which is important in the construction of San Lorenzo is the science and art of stonecutting known as stereotomy. The evolution in the technology of stone cutting involved tools such as the *mesolabio* and the *analemma* to facilitate the cutting of large blocks of stone into complex dimensions.

The evolution of architecture during the late Middle Ages and the cultural confluence of Catholicism, Judaism and Islam during that time period, influence the design of San Lorenzo in a multitude of ways. This influence is most prominent in the central dome above the worship space, as well as in the smaller dome above the sanctuary. All three religions reached a high-point of productivity and architectural sophistication around 1250–1375.

Apart from the religious and symbolic association of the architecture of the Middle Ages, many of the same building systems involving stone masonry and engineering were used. Catholic churches and synagogues both used complex arcuate systems that involved ribbed vaulting made of fortified stonework, involving the use of bosses at the apex of each of the vaults, where molten lead was poured into the ribs. Similar building systems were also used in the design of the interior worship space of the Islamic *maqsura*.

Unlike the attenuated ribbing of the Gothic vault, the intersecting stone catenaries of San Lorenzo's dome are thick, solid and massive, and, therefore, did not require the reinforcement of lead. However, the pattern created by the interlaced ribs of the dome, the bisected quadrilaterals at the center of the cupola which open up to the pattern of round arches in the lantern, create similar structures found in the Gothic church, including lierne vaults, bisected stone crossings and star patterning. The tracery windows of the Gothic church are surpassed at San Lorenzo by creating inset fenestrations separated by the stone vaulting, allowing light to enter like the stellar motion of the night sky.

In 1655, Guarini entered a ten-year period of exile, where he lived and worked on the Iberian Peninsula until undertaking the commission to build Sainte-Anne-la-Royale in Paris in 1665. Working as a studious young architect in Spain and Portugal, he was able to learn about the three great religions of the west in the land of *las tres culturas*; a knowledge that he brings to a culminating point in the design of San Lorenzo.

4.
Interlacted vaulting (detail), San Lorenzo, Turin.
Photography by author,
2018.

The historical influence of time is like a weight similar to gravity. As the world turns, the *axis mundi* swings like the pendulum of a *perpetuum mobile*. Guarini's early experiences in exile on the Iberian Peninsula accounts for more than merely historical and stylistic influence, as it defined his relationship to time that set him ahead as many centuries as he explored further into the architectural past. Because the theoretical influence in his work stems from the ancients (Vitruvius; Eratosthenes; Archytas), and the influence of building technology stems from the medieval world of *las tres culturas*, the historiography on Guarini has been extremely slow to develop over the past three centuries. The emphasis has also been primarily on his built works and mainly from the vantage point of the "grand tour," along with a very minimal understanding of his literary *oeuvre*.

The first publication which adequately begins to describe the complexity of Guarini's architecture was published in 1905, entitled *Histoire de l'art: depuis les premiers temps chrétiens jusqu'à nos jours*, by André Michel.[14] The description of San Lorenzo is not written in passing. It is a critical analysis that includes a consideration of construction methods according to architectonic form.

[14] Wittkower, "Introduzione al Guarini," 21. "*Poi per più di una generazione segue il silenzio: si arriva così praticamente agli anni che seguono la prima guerra mondiale. La critica moderna del Guarini inizia, ritengo, con* l'Histoire de l'Art *del Michel del 1921, nella quale si riconosce nel Guarini uno dei maestri più originali ed interessanti tra quelli che l'intera storia dell'architettura annovera come iniziatori di nuove epoche.*"

Michel does not see a convolution of Baroque forms that leads to an alternative mysticism but rather a system of construction (*système de construction*), an intricate physiognomic framework which seems to defy gravity by upholding the massive stone catenaries of the dome, creating a liberating, open sense of space (*il ne conserve que le nervures qui se croisent dans l'air comme le solides armatures, et par delà l'espace libre laissé entre elles*).[15]

Michel's description of San Lorenzo is both structural and aesthetic and reflects the technological advancements of the Second Industrial Revolution, which spanned from around 1870 to the start of the First World War in 1914. Increasingly complex systems and networks such as railways, electricity, the manufacturing of chemical compounds and the combustion engine, heavily influenced the study (and creation) of art and architecture during that time.

Michel relates mathematics and architecture to "the knowledge of material resistance" (*la connoissance de la rèsistance des matériaux*) and to the vaulting of Gothic churches which influenced Guarini's designs and structural considerations; *rèsistance*—a scientific, Newtonian concept which involves the opposition of any physical force; a political concept or opposition which leads to revolution; an aesthetic counterpoint, countermeasure, or spatial *preforation*, which can also reflect the first and second principles of *rèsistance*.[16]

By creating a point of reference involving the prodigious nature of the Gothic building (*l'architecture gothique est une prodige constructif*), Michel inaugurates Guarini as the

[15] André Michel, *Histoire de l'art: depuis les premiers temps chrétiens jusqu'à nos jours* (Paris: A. Colin, 1921), 70.
[16] Paolo Marconi, "Guarino Guarini ed il Gotico," in *Guarino Guarini e l'Internazionalità del Barocco, Tomo Primo* (Torino, It.: Accademia delle Scienze, 1970), 639.

father of modern architecture. The architects of the mid-to-late twelfth century were portentious in creating buildings based upon a burgeoning field of science which the Arabic world rediscovered and that Europe dutifully received and reinterpreted. San Lorenzo reflects not only Gothic engineering and aesthetics, but Mozaribic and Arabian aesthetics as well. It is not until four centuries later, during yet another distinctive revolution in science and technology, that this counterpoint, this *rèsistance*, is being reevaluated.[17]

The turn of the twentieth century also marks the historical recurrence of another burgeoning period in world history—the age of exploration, which began in the late fifteenth century and led to the age of early-modern globalization. The catalyst behind this burgeoning force of discovery is scientific as well as political. Governance and power fuel the fire for the expansion of terrestrial and aeronautical dominion; globalization synthesizes geography with politics, creating a duality in the motive and impetus behind technological advancements and infrastructure; advancements that redefine the structures of hegemony and social order.[18]

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[17] Ibid., 68–9.

[18] Marcello Fagiolo, "La Sindone e l'Enigma dell'Eclisse" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademia dell Scienze, 1970), 205. Fagiolo's argument pertaining to Guarini's Sindone Chapel, as well as to his theory of what he calls the "Geosofia," reflects in a similar way on Guarini's prodigious nature as an architect, stating that the scientific nature of Guarini's architecture seems to skip ahead three centuries, only to reveal the counterproductive and unevolved use of science as weaponry during the immanent war in Vietnam which raged on at the time (*in questa situazione le nostre armi scientifiche — che fra l'altro non sono evolutissime — si possono rivelare inutili o addirittura controproducenti, come le bombe disseminate nella giungla del Vietnam*). Fagiolo's solution to the problem of interpreting Guarini's treatises is his theory of the 'Geosofia,' which he refers to as the Gospel (*Il Vangelo*), which is a 'certain and causal absolute,' that has been unspeakably neglected. Relating this specifically to the Sindone Chapel, Fagiolo connects the understanding of Guarini and his treatises to the existential relationship of humankind to the Holy Shroud as a reliquary object.

Scientific Advancements and the Brevity of Light

The Enlightenment that followed the Baroque period was marked by fleeting advancement. From a modern vantage point, the ‘objectivity’ of reductivism led to an oversimplification of scientific research based on the well-justified but naïve presumption that church authority merely intended to promote censorship and intellectual oppression.

The Enlightenment thinkers sparked seemingly reactionary theories in science, diametrically opposed to those of the Baroque period. Along with this method of research, the cohort of the Enlightenment expressed a contempt for the church which oppressed their advances and suppressed the publication of their knowledge during the Inquisition.

The Vatican’s concern on these matters as the time of such intrepid advancement concerning negativity and destructive tendencies within scientific discovery is important to consider in conjunction with the precedence of art over pseudo-scientific advancements, intended to either destroy by way of false competition or to complicate matters which may otherwise be seen as simple.

The fleeting advancements in the sciences made by Guarini, Newton, Rømer and Cassini immediately prior to the Enlightenment signify an externalization of scientific thought, a kind of *apostasis* that reached out like the Prodigal Son, beyond the realm of the interior, only to return in *extasis* to God and to the sun once again.

Architectonics built in stone, mortar and glass express the geometric and philosophical knowledge of these scientific theories, elegantly expressed in Guarini’s architectural grammar. The evolution of Guarini’s knowledge culminates in the design of San Lorenzo;

a typology made apparent by a complex system designed around the light of the sun and the intricate mathematics of a heliocentric solar system.

The Fulcrum and the Horizon of History

The symbolic, eidological placement of the *axis mundi* has been demonstrated to reside in the history of the world's cultures. As such, a clarification of methodology must be made here; a clarification pertaining to hermeneutics that rests upon the universality of this axis point and its intersection with history. While everything that resides in the realm of the idea and within mathematics (the *eidos*; mental image) is transversal, the history of the idea is like a seed planted within soil. The sedimentary process which formed the seed in which the idea is planted, maintains a history of its own. As the seed grows and flourishes, the roots spread into this sedimentation, receiving nourishment from it.[19] This connection between idea and history exists, like the plane division between the verticality of the *axis mundi* and the horizon.

The cosmology of the celestial sphere exists as a duality of politics and science, representing an intersection which may also be symbolized by the verticality of the *axis mundi* and the universe which expands forth from it, tending toward infinity. Both aspects pertain to the desire for the knowledge of the universe and the knowledge of God; the expansion of geospatial dominion, like the sedimentation of history that nourishes the seed, bifurcates into structural networks, creating advancements in the fabric of civilization; advancements which crumble into the ruins of prior dominions, creating further sedimenta-

[19] This aphoristic reference may be accredited to two known sources. The first being the parables of Christ, and the second being the dissertation of Jacques Derrida: Biblia Latina Vulgata, Matt…; Jacques Derrida, *Edmund Husserl's Origin of Geometry, An Introduction* Trans. John P. Leavy Jr. (Stony Brook, NY: N. Hayes, 1978), …Derrida relates sedimentation to the historical development of language.

tion, the relics of saints and the bones of the deceased (*ossum hominem*); layers of conquered civilizations that are ever apparent in the eternal city of Rome, uncovered by archaeological expedition and the unearthing of the *Via Sacra*.

5.
View of Turin Cathedral and the Chapel of the Holy Shroud.
Photography by author, 2018.

The nearby Chapel of the Holy Shroud behind the Cathedral of Turin, the chamber in which the Shroud of Turin is housed in its reliquary, represents an aspect of Christ that is at once a microcosm and a macrocosm. A mystery that is as close to our own soul as the hairs that are numbered on our heads, as it is distant as a quasar.[20] On the level of the stars, sudden expansion of supernovae, creates the massive dispersion of atoms and elements, causing the sedimentation of particles into the interstellar medium from which new stars are formed within the increasing density of a molecular cloud.

6.
View from the altar of Turin Cathedral through
to the Sindone Chapel. Photograph by author, 2018.

[20] Biblia Sacra Vulgata, Secundum Mattheum 10:30. "*…vestri autem et capilli capitis omnes numerate sunt*."

The history of an event enters our line of vision at this horizon; events which involve economics, politics, war, peace, the *historicity* of religion and theocratic endeavors and geopolitical advancement. This boundary, this limit (*Quid sit Terminus*) of which the first chapter of the *Placita Philosophica* pertains, is the horizon of all historical events; the celestial axis point, the *axis mundi*, maintains an infinite cardinal point of zero, a location that, while maintaining a locus point, is *aspatial* and *ahistorical*.[21]

The *Placita*, being Guarini's first and primary system of philosophy, is recurrent in the *Civile* as the last publication. In principle, all aspects of Guarini's culminating practical theory of civil architecture can be seen within the abstractions and complexities of his mind as a philosopher—the limit and the horizon of his intellect brought to its culmination at San Lorenzo.

[21] Guarini, *Placita*, [chapter 1].

I

The Prodigious Architect

I intentionally chose to use an otherwise obsolete definition of the term *prodigious* in the title of this first chapter to describe Guarini's life and work. The contemporary use of the word describes something that is incredible or amazing in size, amount or level of ambition.
[1] A term that in and of itself, befittingly describes the depth and breadth of Guarini's life and accomplishments. However, this is a description that is perhaps insufficient. Getting underneath the surface of the word's etymology, the definition deepens in dimension and structure, as in Guarini's progression from two-dimensional surface planes in the *Euclides Adauctus* to their architectural application in three-dimensions.

The second etymology pertains to the term *prodigal* and its variation of definition in usage and application. *Prodigality* expresses a lavish sense of extravagance, opulence and refinement; an element of design epitomized by Theatine architecture and considered desirable by the sovereignties of Europe, some of whom were patrons of Guarini's architectural and literary endeavors. Prodigality lends itself to Biblical parable, expressing Guarini's departure from his place of origin in the fertile valley of the *Pianura Padana*, to his eventual return to the neighboring region of *Piemonte*.[2]

The more archaic, obsolete definition of the term is related to the word *portentious*; similar in nature to *prodigious*, but rather connected to the idea of something being ominous and prophetic, as well as progressive, radical and avant-garde. The definition of Guarini as the prodigious architect and as *prodigy*, is a well-deserved title due to his level of ambition, the lavishness of his design of which the Theatines are known and Guarini's position as a pioneering, prescient figure in the world of seventeenth-century architecture.

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[1] Alberto Pérez Gómez, *Architecture and the Crisis of Modern Science* (Cambridge, MA: MIT Press, 1983), 88. The use of the term prodigious by Pérez Gómez has previously set forth the first definition: "The literary and architectural production of Guarini is prodigious. His writings encompassed the theatre, philosophy, Euclid's *Elements*, astronomy, topography and the mensuration of buildings, as well as an important architectural treatise, as well as an important architectural treatise that appeared posthumously in 1737."

[2] Luke 15:11–32. In the parable of the prodigal son, a father divides his inheritance between his two sons. The younger son squanders the money, and upon his return is unexpectedly forgiven by his father, at the chagrin of the older son. The parable represents the ecclesial morality of foregiveness and mercy as opposed to the expectance of being rewarded, despite our shortcomings.

Origins

Camillo Guarino Guarini was born on the seventeenth of January, 1624 in the north Italian city of Modena. He was baptized at the font of Santa Margherita in the arms of his mother Eugenia Marescotti, his father Rinaldo and his godparents, Marcello Guerenghi and Signora Seghizza.[3] Signore Guerenghi served as the master of robes for the Court of Ferrara, and because of this the Guarini family held an important social stature in the city of Modena and in the region of Emilia-Romagna.[4]

Modena undertook a major religious campaign in the 1620s in a continued effort to counteract the Protestant Reformation and the violent foray of the Thirty Years War, which

[3] The place and time of Guarini's birth can be verified by numerous sources, including: Clara Silvia Roero, "Guarino Guarini and Universal Mathematics" in *Nexus Network Journal* 11, 3 (2009): 417; Robison, "San Lorenzo," 2. Robison derives his biographical information from an earlier source: Sandonnini, "Il Padre Guarino Guarini Modenese," 484–85. Sandonnini has a detailed account of his birth and parentage, including a direct entry from his baptism records: "*Rinaldo Guarini ed Eugenia Marescotti furono i genitori di Guarino, il quale macque il 17 Gennaio del 1624 in Modena sotto l'antica parrochia di Santa Margherita nei registri dei Battezzati della quale si trove scritto*: Battezzati di S.[a] Margherita. Addi 22 Gennaio 1624 – Guarini figlio di S.[r] Rinaldo Guarini et della Signora Marescotti sua moglie fu battezzato. Furono pardini il Signor Marcello Guerenghi et la Signora Seghizza sua moglie." This source is also referenced by Nino Carboneri, "Guarini a Modena" in *Guarino Guarini e l'Internazionalità del Barocco, Tomo Primo* (Torino: Accademia delle Scienze), 47–70; Meek, *Guarino Guarini*, 5; Klaiber, "Theatine Architecture," 16; Rudolf Wittkower, "Introduzione al Guarini" in *Guarino Guarini e l'Internazionalità del Barocco, Tomo Primo* (Torino: Accademia delle scienze, 1970), 21–22; Wittkower, *Studies*, 178; Marziano Bernardi, *Tre Palazzi a Torino* (Torino: Istituto Bancario San Paolo di Torino, 1966), 12; Varriano, *Italian Baroque*, 209; The dates of Guarini's birth and death are also stated in: Amelio Fara, "Geometrie della fortificazione e architettura da Borromini a Guarini" in *Mitteilungen des Kunsthistorischen Institutes in Florenz*, 45. Bd., H. 1/2 (2001): 102. "*Può apparire soprendente, ma per intendere l'essenza geometrica, finora rimasta nascosta, dell'architettura di Francesco Borromini (1599–1667), e di Guarino Guarini (1624–1683)…*"; Meek, *Guarino Guarini*, 5.

[4] Susan Klaiber, "La Formazione di Guarini," in *Guarino Guarini*, ed. Giuseppe Dardanello, Susan Klaiber and Henry Millon (Torino: Umberto Allemandi & C., 2006), 23. "*Guarino Guarini proveniva da una famiglia con una certa posizione nella società modenese ed ebbe come padrino un maestro di guardaroba alla corte estense…*"; Susan Klaiber, "Theatine Architecture," 16. "The Guarini family, as well, boasted prominent, if not noble origins: according to two Modenese contemporaries, the Guarini of Modena were a branch of a great family from Verona and Ferrara, and the Theatine historian Silos described Guarini as '*honestis parentibus Mutinensis*.'"; Giuseppe Silos, *Historiarum Regulorum Clericorium: a regularum condita, vol. iii* (Palermo: Petri de Insula, 1666), 572. "*Guarinus Guarinius honestis parentibus Mutinensis, admissus in Ordinem Mutine….*"

began in Germany in 1618, creating a series of politico-military entanglements that engaged the Catholic church and the monarchy across the broad expanse of Europe until the end of the Counter Reformation in 1648.[5]

While Lutheran architecture sought to distill, to vehemently clarify and to expose the sumptuousness of the Catholic church with austerity, the architecture of the Counter Reformation provided an object of beauty, sensuality and desire; resting upon the tendrils of Ionic volutes and the chasuble lace of penitent priests, the Baroque church retaliated with extravagance perhaps only matched by the *flamboyant* churches of Medieval France.

The flourish of the Baroque during the period of the Reformation was met with an even greater degree of ecclesiastical ostentation, expressed in the theatricality of art and architecture, but also in theology and liturgical structure. The Reformation also brought forth a number of new religious orders and confraternities including the Theatine Order, founded in 1524, the year of the Church's decision to form an ecumenical council that led to the Council of Trent in 1545.

The Theatine Order began as a confraternity called the *Sodalitium Divini Amoris*, which was started by Gian Matteo Giberti (1495–1543) and Gian Pietro Caraffa (1476–1559) in 1516. Giberti was born in the south of Italy, in Palermo, Sicily. He entered the house of Cardinal Giulio de' Medici in 1513, where he learned Latin and Greek and was admitted to the *Accademia Romana*. The cardinal soon appointed him as secretary in Rome, where he also worked for Pope Leo X (r. 1513–1521). Giulio de Medici would soon become Pope Clement VII after Pope Adrian VI, who reigned for only one year, from 1522

[5] M. Capucci, "Guarino Guarini Letterato," *Lettere Italiane* 8, 1 (1956): 75.

to 1523 after the repose of Leo X in 1521. Giberti's religious devotion led him to form the *Sodalitium* prior to his ordination to the priesthood in 1521.

Caraffa was born in Benevento in 1476 into one of the wealthiest and most noble families in Naples. His close relative, Cardinal Oliviero Caraffa (1430–1511), introduced Gian Pietro to the Papal Court in 1494. Soon thereafter he took charge of the See of Chieti in Abruzzi, from which the word *Theatine* is derived. After seeking admission to the Dominican and Camaldolese Orders, he became associated with Gaetano dei Conti di Tiene (also known as Saint Cajetan) in the founding of the Theatine Order. In 1555 Caraffa was elected pope in succession of Pope Marcellus II and took the name Pope Paul IV.

In 1524, Caraffa, along with Paolo Consiglieri (1499–1557), Bonifacio da Colle (d. 1558) and Gaetano dei Conti di Tiene (1480–1547) founded the Theatine Order, with the intent of forming a body of clerics regular that followed the principles of the Counter-Reformation.[6] The Theatine Order gained a great deal of power during the Counter-Reformation, developing a theology based around the importance of the sacredness, the altar and the Eucharist in a manner that was flagrantly expressed with an impassioned desire for beauty and for God. The communal recitation of the divine office expressed a kind of monasticism that polarized itself against the public, secular aspect of their ministry. Their lavishly decorated altars and churches expressed an extravagant wealth which was paradoxical to the Theatine vow of poverty, which strictly prohibited the taking of benefices, incomes and real estate.[7]

Their order spread across Europe during the sixteenth century, kindled by the financial patronage of the Savoy Dynasty in many of the cities in which Guarini lived and

[6] Klaiber, "Theatine Architecture," 9.
[7] Quoted in, Robison, "San Lorenzo," 75.; Klaiber, "Theatine Architecture," 10.

worked, including Turin, Modena, Messina, Paris and Lisbon.[8] The Theatines became one of the most prominent orders in Europe until they fell into decline at the end of the eighteenth century, due to internal issues within the church related to politics and finance.

Three new orders followed in the wake of the formation of the Theatine Order: the Barnabites, founded in 1530 by Saint Anton Maria Zaccaria (1502–1539), Barthélemy Ferrari (1499–1544) and Jacopo Morigia (1497–1546); the Jesuits, founded in 1540 by Saint Ignatius of Loyola (1491–1566), Saint Francis Xavier (1506–1552) and Peter Faber (1506–1546); and the Oratorians, which were founded in 1575 by Saint Philip Neri (1515–1595), but not officially approved until 1612 by Pope Paul V (1550–1621).[9]

The Guarini family lived in close proximity to the Theatine Church of San Vincenzo, which was under renovation by Bartolomeo Avanzini (1608–1658) as part of Modena's religious campaign.[10] San Vincenzo, originally designed by Paolo Reggiano, was founded by the Theatines in 1617 and designed after the mother church of their order, Sant' Andrea della Valle in Rome.[11] The neighborhood church of San Vincenzo played a direct impact on Guarini's interest in architecture and his invested interest in the Theatine Order.

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[8] Ibid., 25.

[9] Ibid., 16; Edward A Pace, Condé B. Pallen, Thomas J. Shahan and John J. Wynne, eds. *The Catholic Encyclopedia* (New York: The Encyclopedia Press, Inc., 1922), 722.; Meek, *Guarini*, 5.; There is a great deal of knowledge pertaining to the Theatine Order and other Counter-Reformational orders that came about during Guarini's time. For further study, refer to the following sources: Klaiber, "Theatine Architecture," 9. "The Theatines were the first to be founded among the various orders and congregations which would later become associated with the Counter Reformation such as the Barnabites, Oratorians and Jesuits; John Varriano, *Italian Baroque and Rococo Architecture* (Oxford: Oxford University Press, 1986), 15–16. "Of equal importance for late Renaissance and early Baroque architecture was the impetus for new sacred construction resulting from the Counter Reformation's emphasis on the establishment of new religious orders. Between 1524 and 1575, the Barnabite, Jesuit, Oratorian, and Theatine orders came into being, and as their influence spread, more and more new churches were built.

[10] Sandonnini, "Padre Guarino," 489. "*I Teatini atterrata la vecchia chiesa di San Vincenzo nel, 1617 con pompa solenne posero la prima pietra del nuovo tempio e della nuova casa.*"; Robison, "San Lorenzo," 5. Robison also suggests that Guarini's early interest in architecture is evidenced by his involvement in the continued construction of San Vincenzo, during his return to Modena in 1647. He also notes that Guarini was elected supervisor of the building site and worked under Bernardo Castagnini; Carboneri, "Modena," 50.

[11] Sandonnini, "Padre Guarino," 491.

The latter result of this impact will include his return to Modena in 1648, where he will work on further renovations under the architect Bernardo Castagnini (c. 1603–1658).[12]

Guarini devoted himself to the study of philosophy, theology, astronomy and mathematics at an early age. He developed a belief in the fundamentality of mathematics and it is through the knowledge of this discipline that he discovered architecture.[13] He would later write that architecture is merely a disciple of mathematics, a constructive application of a branch of mathematics known as geometry.[14]

Following the chosen path of his eldest brother Eugenio, Guarino entered the Theatine Order (*Ordo Clericorum Regularium vulgo Theatinorum*) as a novitiate on the twenty-seventh of November, 1639 at the age of fifteen. His precocious ability as a scholar brought about this early initiation along with his godfather's role in the Court of Ferrara. However,

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[12] Klaiber, "La Formazione di Guarini," 25.

[13] Carboneri, "Modena," 47. "*L'esordio Modenese di Guarino Guarini non offer motive di eccezionale interesse: egli dedicò probabilmente la maggior parte degli studi giovanili alla Filosofia, alla teologia, all'astronomia e alla matematici, giungendo per via di quest'ultima all'architettura: procedimento astratto, non confortato, almeno al principio, da una diuturna pratica di mestiere, né mai sostenuto da un'attivita professionale nel senso proprio della parola.*" It must be noted however that it is unclear as to where Carboneri draws the conclusion about Guarini's early life as an architect as lacking in professional experience. Carboneri's citation is generally noted as pertaining to, Sandonnini, "Padre Guarino," 483–534. However, this is non-specific, as it references the entire chapter.; Meek, *Guarini*, 6.

[14] This reference to architecture as the disciple of mathematics is found in several places: Guarino Guarini, *Architettura Civile* (Milano: Edizioni Polifilo, 1968), 18. "*Delle operazioni per così dire infinite che i matematici vanno esercitando con evidenti dimostrazioni, ne sceglieremo alcune le più principali, che sono necessarie all'Architettura, senza però arrecare le prove, perchè questo si è proprio uffizio della Matematica, di cui l'Architettura si professa discepola*."; ibid., 10. "*L'Architettura, sebbene dipenda dalla Matematica, nulla meno ella è un'arte adulatrice, che non vuole punto per la ragione disgustare il senso: onde sebbene molte regole sue sieguano i suoi dettami, quando però si tratta che le sue dimostrazioni osservate siano per offendere la vista, le cangia, le lascia, ed infine contradice alle medesime; onde non sarà infruttoso, per sapere quello che debba osservare l'architetto, vedere il fine dell'Architettura, ed il suo modo di procedere*."; Ibid., 36. "*Delle operazioni per così dire infinite, che i matematici vanno esercitando con evidenti dimostrazioni, ne sceglieremo alcune le più principali, che sono necessarie all'Architettura, senza però arrecare le prove, perché questo si è proprio uffizio della Matematica, di cui l'Architettura si professa discepola*."; Also quoted in Roero, *Universal Mathematics*, 416; this statement is also quoted, although not in completion in, Werner Müller, "The Authenticity of Guarini's Stereotomy in His 'Architettura Civile'" in the *Journal of the Society of Architectural Historians* 27, 3 (1968): 202; Also, for a slightly variant reference, see Kruft, *Architectural Theory*, 106. "Like most theoreticians since Vitruvius, Guarini perceives architecture as a science."

the required age to begin formation was seventeen, with seminarians completing their studies at receiving ordination at twenty-four. Because of this stipulation, it was not until the fifteenth of April, 1641 that he was formally voted into the order by ballot and went to Rome to begin his studies at the seminary of San Silvestro al Quirinale in Rome.[15]

Theatine formation, like the Jesuits, is a lengthy seven years; three years of philosophy followed by four years of theology. The study of philosophical logic in the first year facilitated the development of cognition and criticality with which to properly approach the Bible and other theological texts. The second year involved the study of Aristotle and Euclid, which were important in creating a logical connection between the physics, found in Aristotle's *Physica* and astronomy in the *De Caelo* to the geometry and mathematics in Euclid's *Elements*.

The syntagmatic connection between the disciplines represented in these books will become particularly important in the development of Guarini's mechanical understanding of the universe which he applies directly to the art of building. The third year was devoted to metaphysics, which connects philosophy to Catholic theology and to the theory of instrumental causality. The theory of causality will influence Guarini's later writings that are found in the *Caelestis* as it pertains to God as the font of light. The subsequent years that follow are steeped in the writings of St. Thomas Aquinas and the careful study of the *Summa Theologica* as well as other sources of Thomistic theology.[16]

[15] Robison, "San Lorenzo," 3.; Klaiber, "La Formazione di Guarini," 23.; Wittkower, "Introduzione al Guarini,": 21–22.

[16] Klaiber, "La Formazione di Guarini," 23. "*Come i Gesuiti, I Teatini studiavano tre anni filosofia e poi quattro anni teologia. In entrambi gli ordini il primo anno di filosofia era dedicato alla logica, il secondo alla filosofia naturale con la* Fisica*, il* De Caelo *di Aristotele e gli* Elementi *di Euclide, il terzo alla metafisica. I corsi di teologia si basavano principalmente su Tommaso d'Aquino.*

Like a great number of orders since the thirteenth century, the seminarians of San Silvestro studied the Bible (*sacra doctrina*) with Thomas Aquinas' (1225–1274) *Summae Theologicae* (1265–74) as a literary companion. Aquinas wrote the *Summae* as a method of engaging the soul and the mind in reading and interpreting scripture through the use of the rational mind; a method which he called "the ultimate purpose of being human, divided into eight articles" (*de ultimo fine hominis, in octo articulos divisa*).[17] The literary structure of the *Summae*, along with other methodologies, has come to be known in more recent history as systematic theology; a term more associated with cold industrialism than human purpose.

Prior to the completion of the *Summae*, Aquinas was commissioned by the Dominican Friar Raimundo de Peñafort (1175–1275) to write the *Summa Contra Gentiles* (Treatise for the Gentiles) to support the mission of creating interfaith ecumenism and *convivencia* between the Catholics, Hebrews and Arabians in the world of *las tres culturas*. The broader meaning of the *Contra Gentiles* defined the 'gentiles,' as those that were considered outside the cultural and religious sphere of any or all of the three predominant religions.[18] The theology of the *Contra Gentiles* presents a universal understanding of the relationship between God and the human soul; a relationship which exists *a priori* to the established doctrine of any of the *culturas*.

The eight articles of the *Summae Theologicae* developed out of the *Contra Gentiles* as core principles intended to engage the intrinsic faculties of the soul; the soul functions

[17] Aquinas, *Summae*, 1.
[18] The definition of 'gentile' applied here, comes from the Carthusian Latin-French dictionary *Ferminus Verris* of 1440. Published roughly two-hundred-and-fifty years after the *Summa Contra Gentiles*, it refers to someone who is neither baptized Christian, Jew, Pagan or Sarracen—an outsider. They are the non-religious and those considered outcast. Also note that '*contra*' in Latin and Italian as opposed to modern English is defined as 'with them' rather than against, while against is defined as '*opposto*' or '*oppositare*.'

intrinsically upon its own principles (*ipse est suorum operum principium*) and extrinsically on the ability of free will (*quasi liberum arbitrium habens*) guided by the innate, individual knowledge of the presence of God within the human soul.[19] Both documents represent one of the most adamant and rebellious defenses of intellectual freedom within the development of the liberal arts at schools such as the Universities of Bologna, Oxford and Paris.

Each of the eight articles coincides with the eight Beatitudes. The desire for knowledge (*quaeruntur*) is a precursor to the first principle. It is the poverty of the soul that acts as the catalyst for the ultimate quest (*beati pauperes spiritu quoniam ipsorum est regnum caelorum*).[20] The first principle (*ad primum*) defines the question, while the last principle (*respondeo*), is the answer. The second principle develops thought (*ad secundum*), further cognition (*praeterea*) and toward the contradistinctive argument (*sed contra*). It is intended to guide one back to the principle, in order to allow one to distinguish between the principle and the source (*respondeo*) and to develop one's inherent knowledge of God into an intellectual understanding (*homo factus ad imagine Dei dicitur, secundum quod per imagenem significatur intellectuale*). The *Summa* is written to expound upon the Bible in relation to the entire experience of being human (*ultimus omnium hominum*) and how to properly apply one's rational knowledge of God to life (*proprium rationalis naturae*).

The eight books of Guarini's *Placita Philosophica* (System of Philosophy): *Proemium*; *Physicae*; *In Libros de Caelo & Mundo*; *De Luce*; *In Libros Generatione et Corruptione*; *De Viventibus*; *De Substantiis Separatis*; *Metaphysica*, also resemble the *Summae* in

[19] Thomas Aquinas, *Prima Secundae Partis Summae Theologicae* (Turin, Italy: Nicolai Beuilaque, 1581), 1.
[20] Secundum Matteum, 5: 26.; Matthew 7: 7. "Seek and you will find; knock and it will be opened to you."

both principle and structure (*omnis veritas propositionis habetur à veritate rei*).[21] In principle, Guarini defends the importance of the knowledge of the individual soul in communion with God, nature and the universe (*sed de his similibus universalibus non agitamus quaestionem; sed de universali in praedicando, scilicet naturâ, quae est communis individuius*).[22]

Peñafort set forth a team of Dominican missionaries at a time when many of the mosques and churches that Guarini may have visited during his subsequent period of exile were being built and renovated; an influence which will eventually lead to his design for San Lorenzo's dome, resembling the skylight above the *maqsura* of the cathedral mosque of Córdoba. The dome over the sanctuary of San Lorenzo in the shape of the Seal of Solomon represents a connection to Judaic theology and the inner sanctuary, the *sanctum sanctorum* of the tabernacle.[23]

The influence of the *Summa Contra Gentiles* is significant as one of the main theological undercurrents in the *Placita Philosophica*. Guarini's decision to have travelled to the Iberian peninsula during his exile is clearly based on the knowledge he gained at San Silvestro of that document. His writings in the *Placita* reveal an interest in the *Summa Contra Gentiles* that leads to the celebration of *las tres culturas* at San Lorenzo in a way that can be seen by incorporating both Judaic and Islamic symbolism in the church.

The deep structure, the underlying geometries and theoretical principles of the architects of Spain and Portugal were the precedent of Guarini's accomplishments in building. The architects of this lineage created a complex relationship between architecture and

[21] Guarini, *Placita*, 36.
[22] Ibid.
[23] Thomas Aquinas, *Summa Catholicæ Fidei Contra Gentiles* (Antwerp: Ioannem Keerbergium, 1612), 28.

science steeped in Neoplatonic and Aristotelian principles that foreshadow a movement toward the divided rationalism of the Enlightenment. Guarini represents the end of this lineage and possibly the end of the Baroque period.

Guarini's education at San Silvestro developed into his knowledge of the universe as a stratified system. Layer upon layer of information which coincides at tangents, extensions, planes, points and fulcrums through an understanding of the universe by means of geometrical and mathematical structures correlate with the architectonics, arcuate systems and cupolas of which his architecture, including San Lorenzo, would be constructed. These structures within San Lorenzo, in turn, fold back upon their origin to form a structural simulacrum with light—the primary substance which for Guarini was synonymous with God.

The Theatines taught that mathematics is both didactic and theoretical. Architecture is only one branch of mathematics, which is a universal principle. Guarini states that architecture is a disciple of mathematics and is thereby at the service of mathematics. As a man of multiple disciplines, Guarini saw mathematics and its application to its various branches as the fundamental principle of a stratified system. Mathematics gives the universe structure. This structure can be expressed architectonically and is cohesive to the light of the sun and the movement of the universe.

This emphasis influences Guarini's architecture, in which architectonics are a manifestation of mathematics beyond calculation and planimetry and are thought of on a highly theoretical level. His conception of the universe relegated by numbers at its core held deep theological significance, writing in *Euclides Adauctus* that "indeed the incomparable magic and miracle of mathematics represents the true gifts that architecture holds."

Guarini's education at San Silvestro was far from only literary, as he learned from many of the greatest early-to-mid Baroque architects as many of their buildings were still going up in Rome. The religious campaign in Modena that began in the 1620s coincided with one of the largest building projects in Catholic history under the papacy of Urban VIII (r. 1623–1644). Gianlorenzo Bernini (1598–1680), Francesco Borromini (1599–1667), and Pietro da Cortona (1596–1669), three of the greatest papal architects of their time, built a multitude of churches that radically tested the limits of architectural expression in a manner that had not been previously challenged.[24]

This cohort of architects served the political motivations of the pope and the Barberini family by strengthening the cultural and intellectual façade of the Church by internally providing a massive amount of funding for these projects, fueled by the Pope's military campaigns beyond the boundaries of the Papal states, into Mantua and Piacenza.

While at the seminary of San Silvestro in Rome, Guarini was exposed to Bernini's Church of San Bibiana (1624–26) and the Baldacchino of Saint Peter's Basilica (1624–33). He would have seen the high altar of San Giovanni di Fiorentini, designed by Cortona in 1634. Borromini's San Carlo alle Quattro Fontane underwent construction a year prior to Guarini's arrival, along with the Oratory of Saint Philip Neri in 1637 and Sant'Ivo alla Sapienza in 1642. The stylistic influence of the work of these architects during Guarini's time in Rome is beyond the scope of my research in terms of providing evidential documentation of any reference to, or meeting between these architects.[25] However, a structural,

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[24] Meek, *Guarini*, 5.; Susan Klaiber, "La Formazione di Guarini," 24.

[25] Klaiber, "Theatine Architecture," 17; Robison, "San Lorenzo," 4. Robison is also reticent to confirm any possible relations with these architects, stating that, "The absence of any documentation regarding his activities during his novitiate does not allow us to draw any firm conclusions regarding Guarini's possible relationships with these architects. Moreover, care must be taken in making assumptions about such connections,

geometric and iconographic reading of the façades and ornamentation of these buildings reveals an evident influence.

Borromini's concave/convex design for the façade of San Carlo alle Quattro Fontane in relation to the concave façade of Guarini's Santa Maria Annunziata (c. 1660–1662) is an important structural point of comparison. The oval-shaped groundplan of San Carlo is related geometrically in many ways to Guarini's design for Santa Maria d'Aracoeli in Vicenza. The inventive ornamentation of the façade of San Carlo in relation to the passion capitals of Guarini's Chapel of the Holy Shroud is yet another. The dome and lantern of Borromini's Sant'Ivo bears many stylistic and structural similarities to the dome of Guarini's Chapel of the Holy Shroud.

for while Guarini's works demonstrate knowledge of Bernini's and Borromini's works, the working methods and artistic ideals remain distinct." John Hendrix, *The Relation Between*, 6. Hendrix states plainly that Guarini did study the work of Borromini while in Rome and that he is at the conclusion of a period of theoretical architects, who rely largely on Neoplatonic theory, and at the beginning of the mechanistic view of Organic Rationalism brought about by the philosophy of Gottfried Wilhelm Leibniz.

Upon completion of the seminary in 1647, Guarini returned to Modena where he was ordained in 1648 and worked on the renovations of San Vincenzo.[26] In 1649 Guarini was appointed as site supervisor, working under the Theatine architect Bernardo Castagnini. In 1651, the *capomastri* expressed concerns about the ability of the church to support the weight of the dome, which was originally built by Avanzini. Guarini proposed a solution, creating a lighter and more structurally sound design for a new dome which was completed in 1653.

Although Guarini's participation in the renovation of San Vincenzo was praised by the Theatine Order, the result was not another building commission but the appointment to an educational and administrative role. Guarini was entrusted with the position of lecturer in philosophy at the Theatine convent in Modena in 1650. Seven months after taking over his brother's position as legal administrator (*procuratore*) in place of his older brother Eugenio, he was appointed as provost (*preposito*) in 1655. However, Duke Alfonso d'Este

[26] Klaiber, "La Formazione di Guarini," 25.; Many sources state that Guarini took his vows in Rome eight years after his entrance into the seminary in 1639: Varriano, *Italian Baroque*, 209; These dates are also verified by: Rudolf Wittkower, "Introduzione al Guarini," in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademia delle Scienze, 1970), 21–22.; Klaiber offers an abbreviated history of Guarini's life from the time of his ordination to the priesthood: Klaiber, "Theatine Architecture," 209. "In 1647, after eight years of study in Rome, he took the vows of the Theatine order and subsequently taught philosophy, theology, and mathematics in Theatine seminaries in Modena, Messina and Paris." The completion of Guarini's time in the seminary is also mentioned in Robison, "Optics and Mathematics," 384; Sandonnini, "Padre Guarino," 489. Sandonnini states that Guarini did not stay in Rome for more than six years, and returned to Modena, enriched by his studies in philosophy and theology, where he also became a lecturer in those subjects. "*La dimora del Guarini in Roma non dovette oltrepassare i sei anni, ed egli ritornò in patria fornito di studi profondi, specialmente in filosofia e teologia…Una prova poi ben chiara della stima che godeva fra i suoi teatini e della conoscenza profonda che' egli aveva della discipline filosofiche e teologiche l'abbiamo nel' 1650, quando il padre generale avendo promesso di concedere ai Teatini di Modena lo studio di filosofia, costoro, oltre ringraziarlo, prospero di chiedergli nello stesso tempo il Guarini per lettore.*"

desired Castagnini instead for the role of provost. Guarini renounced his position and was forced into exile.[27]

The Theatine Order at Parma voted to accept Guarini into their chapter upon hearing of his exile, expressing a respect and admiration of his talents and that the Duke's treatment of him was unwarranted. For Guarini to provide a complex, sophisticated solution to Avanzini's dome while working as site supervisor under Castagnini as a recently ordained priest demonstrates a powerful and precocious ability which led him to quickly advance in the role of administration.

Guarini's subsequent exile is a significant turning point in the life of the young architect as it demonstrates a quick and powerful advancement within the order to the point of being driven out completely beyond its ranks. As in the story of the prodigal son, Guarini leaves his native region of Emilia-Romagna, setting out on a journey which will bring him several architectural commissions across the continent of Europe.

Duke Alfonso's decision to drive Guarini out of the order provided a liberating alienation and a freedom from the bureaucracy of an administrative post. This expulsion brought forth the opportunity for travel, for study and to be influenced by architecture far beyond the realm of northern Italy. It also allowed Guarini to continue being employed in academic, rather than administrative positions, eventually taking positions as a professor

[27] Ibid., 7; Carboneri, "Modena," 48.; Robison, "San Lorenzo," 8; Elwin C. Robison, "Optics and Mathematics," 384.; Carboneri, "Modena," 47–48. "*Tornato a Modena nel 1647, fu consecrato sacerdote ed ebbe via via mansion di sempre maggiore responsibilità nel suo convent, fino alla nomina a procuratore nel 1654, in sostituzione del fratello maggiore, Eugenio, trasferito a Ferrara. Infine fu eletto preposito agli inizi del 1655; già nel 1650 gli era stato affidato l'incarico di lettore di Filosofia*." This account is also told by, Robison, "San Lorenzo," 7; Rudolf Wittkower, *Art and Architecture in Italy 1600–1750*. (Singapore: Penguin Books, 1958), 29.

of mathematics and philosophy at Theatine seminaries in Modena, Messina and Paris.[28] His work on some of the projects from this point forward exhibit the development of asymmetrical geometries, as well as design plans that begin to foreshadow the plans for San Lorenzo by using interlocked systems of rib vaulting for the structure of the domes.[29]

The period of time from the point of Guarini's expulsion in 1655 to when he surfaces in Messina in 1660 has been a topic of great contention, speculation and refutation.[30] A great number of articles in the past fifty years have brought forth well-documented research of Guarini's time on the Iberian peninsula. However, Guarini's dedication page of the *Placita Philosophica* to his patron, Francisco de Mello et de Torres (1610–1677), Count of Ponte de Lima provides one of the clearest records.[31]

Mello was an ambassador to the court of France, the Marquis of Galicia (*Sande*) and a diocesan cleric and commendator of six parishes across the regions of Portugal, Spain

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[28] Robison, "San Lorenzo," 29; Klaiber, "Theatine Architecture," 209. Klaiber also gives an abbreviated history of Guarini's move from the seminary to his work as an academic abroad: "In 1647, after eight years of study in Rome, he took the vows of the Theatine order and subsequently taught philosophy, theology, and mathematics in Theatine seminaries in Modena, Messina and Paris"; Meek, *Guarino Guarini*, 19; Hendrix, *The Relation Between*, 47.

[29] Robison, "San Lorenzo," 12.

[30] Guarini's travels, according to Robison, are a point of contention: Robison, "Optics and Mathematics," 384. For further evidence pertaining to these travels, as well as to how the Moorish influence in Guarini's Sicilian article may have come about, see: Meek, "Guarino Guarini," 12. As Meek points out, the church listed in Guarini's *Architettura Civile*, Santa Maria della Providenza, is located in Lisbon, Portugal. For illustrations of this church, refer to, Guarini, *Architettura Civile*, tav. 16 and 17.; Adolfo Florensa, "Guarini ed il Mondo Islamico" in *Guarino Guarini e l'internazionalità del Barocco, Tomo Primo* (Torino: Accademia delle scienze, 1970)," 638. "*Messina, conquistata dagli araba nell'843, ne era stata definitivamente liberate solo nel 1060; e la naturale reazione ai due secoli di occupazione avava fatto subito sparire, violentemente, quasi tutti I segni Preziosi della permanenza islamica, sostituendoli con le opera della nuova architettura che rappresentava in un certo senso l'evoluzione, forse il rimpianto dell'antico splendore.*"

[31] Paulo Varela Gomes, "Guarini e il Portogallo" in Giuseppe Darandello, Susan Klaiber and Henry A. Millon eds., *Guarino Guarini* (Turin: Allemandi, 2006), 515. "*La prima data documentata dell'incontro tra Guarino Guarini e il Portogallo risale al 1665, anno in cui fu pubblicato a Parigi il suo trattato* Placita Philosophica *con la dedica all'ambasciatore portoghese alle corti di Francia e di Gran Bretagna Francisco de Mello Torres, marchese de Sande (1620–1667).*"

and Brittany in the north of France.[32] Guarini's dedication establishes that the Royal Families of Spain acted as patrons in this stage of his early career, including Seville (*Hispalis*) and Portugal, including Transtagana and Lusitania in the province of Estramadura, of which Lisbon is the capital, as Guarini states in the foreword to the *Placita Philosophica*.[33]

The conditions of Guarini's exile presented an opportunity to see the world beyond the Apennine peninsula; it was the initiation of a peripatetic journey, a "*contemplator terrarium orbis*," that dramatically changed the course of his life and work as an architect.[34] Guarini's relationship to Mello as a nobleman and fief is an important moment in the development of his early career, considering the alienating, discrediting conditions of his expulsion. Accordingly, Guarini expresses gratitude for the magnanimous circumstances of their friendship, commending the zealousness of Mello's mind, his humanity and his far-reaching spirit (*Magnanimum in nostram congregationem propensae tuae voluntatis studium, & singularem excelsi licèt animi humanitatem*).[35]

The *Placita Philosophica* is Guarini's first major literary undertaking and it is his exile that momentarily provides him the solace and detachment with which to write. The

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[32] Guarino Guarini, *Placita Philosophica* (Paris: Augustæ Taurinorum, 1665), (unpaginated). The frontispiece of Guarini's dedicatory forward introduces Torres as the commendator of the following six parishes: "*Commendatario Ordinis Christi, Commendarum S. Mariae de Montemor, S. Petri finis da Marinha, S. Martini di Frexeida, S. Iacobi di Guidofen, S. Salvatoris de Fornellos, & S. Michaelis de Fornos, Serenissimo Lucitaniae Regi à Consiliis status, ac belli, eiusdemque apud Magnae Brittaniae Regem extra ordinem Legato, & c.*"; Lange, "Disegni e Documenti di Guarino Guarini," 110. "*Noi sappiamo che non solo era occupato nel progetto e nell'esecuzione della chiesa, ma attendeva a terminare e far pubblicare il grosso volume in-f° dei Placita Philosophica che uscirà a Parigi nel 1665 (la dedica ha la data 13 gennaio 1665*)."

[33] Guarini, *Placita*, unpaginated. "*Ecce non solùm Regem Lusitaniæ, voce tribuere note, at etiam proprij sanguinis murice Regium paludamentum imbuere, diademati vulneribus gemmas addere, linguâ & pugione asserere, triumphosque captivos in obsequium tui Regis non semel trahere, tibi non ignotum…Fremit adhuc Hispalis, & Transtaganæ Provinciæ quondam Gubernatorum te adhuc præ oculis habet, armatas manus usque ad muros suos ducentem, arcibus præruptis minantem, urbisque populosæ, agros, villas, castra, æquali, & semper victorioso, pede proterentem, cùm illa interim hiscere nec collectis quidem viribus auderet. Nimis me detineret Epistolæ, si in singulis velim immorari victoriis, singular vel brevi stylo demirari trophæa….*"

[34] Guarini, *Placita*, unpaginated.

[35] Ibid.

final result, when the treatise was finally published in 1665, was a massive 868-page treatise establishing Guarini's system of philosophy—a system which he later applies to his other treatises on mathematics, astronomy and architecture. Guarini's dedication to Mello is, therefore, an expression of intellectual labor, in which the flourish of his pen transforms the weight of his knowledge into the glory of the sun (*in lucem meos labores prolaturus tibi gloriae Soli*).[36]

The Theatine Order had already established themselves in Lisbon by 1648, several years prior to the beginning of Guarini's Iberian sojourn. It is in Lisbon that Guarini reestablishes himself as a practicing architect with the design for Santa Maria della Divina Provvidenza, a longitudinal church on the site of the new Theatine convent. His involvement with the Theatine chapter in Lisbon also allows him to establish new lines of patronal influence, which lead to the subsequent commission of Sainte-Anne-la-Royale in Paris.

The development of the new Theatine convent in Lisbon was financed by the patronage of the Court of Portugal, who granted them a narrow piece of land, awkwardly situated between other preexistent buildings.[37] It is possible that the land was owned by Mello as a vacant benefice under his ownership as a commendator.

There are three sources that document the development of the convent and a church on the site. The first set of plans are depicted by the Theatine cleric Antonio Ardizzone Spinola (1609–1679), which are later published as plates seventeen and eighteen in Guarini's posthumous *Dissegni d'architettura civile et ecclesiastica* (1686), a set of engravings

[36] Ibid.
[37] Gomes, *Portogallo*, 516.

which eventually became incorporated into the *Architettura Civile* (1737). Spinola's footprint and elevation studies depict Guarini's proposed design for a longitudinal church on the site named Santa Maria della Divina Provvidenza.

Spinola served as provost for the order in Lisbon in the mid-1650s, overseeing the construction of the first phase of the Theatine convent between 1673 and 1675. By the end of the seventeenth century, another phase in the development of the convent included a longitudinal church, considered to be a reformulation of Guarini's original plans for Santa Maria.[38]

Guarini's presence as a Theatine architect in Lisbon connected him to the social sphere of the royal court. Mello's circle of influence included Spinola along with several other Theatine prelates that were transferred to Lisbon from Paris. Mello's association with the Italian cardinal Jules Raymond Mazarin (1602–1661), placed Guarini in connection with Camillo Sanseverino, the Theatine provost that served as superintendent for Guarini's Parisian commission for Sainte-Anne-la-Royale.[39]

Guarini's design for the church of Santa Maria della Provvidenza was never brought to fruition as he originally intended. However, this does not diminish the importance of the church's design in understanding the early stages of his evolution as an architect. Guarini's work in Lisbon also facilitated the development of a collegiate relationship with Mello and Sanseverino who from this point on, takes a close interest in studying and providing patronage to Guarini's work as an architect, as well as his early research into mathematics and astronomy.[40]

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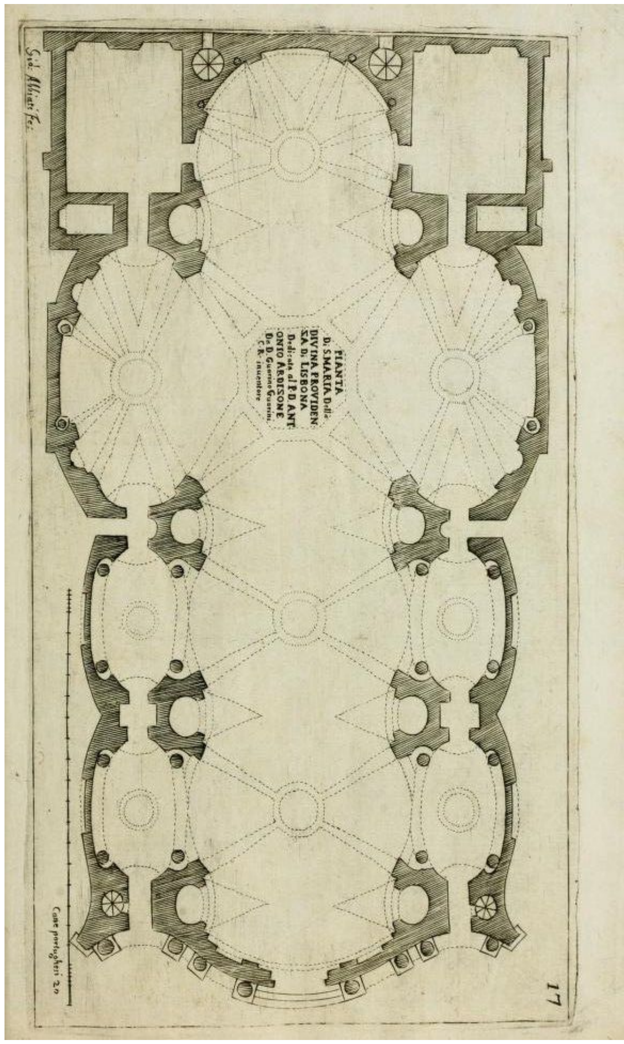
[38] Ibid., 518. "1748 drawing by Potoghese architect…"
[39] Gomes, "Portogallo," 518-19.
[40] Ibid.

By surface appearance, Guarini's design for Santa Maria is a longitudinal, cruciform church. The Borrominian influence can be seen in the sinusoidal, concave/convex form of the façade and the use of elliptical shapes for the crossing, the apse and the chapels that echoes the design for San Carlo alle Quattro Fontane (1638–46).[41] His time as a seminarian at San Silvestro surely accounts for the Roman influence in his early design.

Andrew Morrogh's brief analysis of Santa Maria applauds Guarini's originality and individualism, coupled with a fair degree of criticism. Concerning the transepts, Morrogh refers to them as 'weak' and 'procrustean,' in that they only define a very awkward confined geometry that does not provide adequate space for the clerestory or the vaulting.[42] However, the eccentricity of the two ellipses that form each transept is greater than that of the side chapels; the center of the transept is also pushed outward, which shifts the center of the ellipse, pushing it outward to create a harmonic chord in the distance created between the transepts and the crossing.

[41] Morrogh, "Pursuit of Originality," 11.
[42] Ibid., 16.



7.
Santa Maria della Provvidenza, ichnography

The influence of elliptical geometry and concave/convex forms in the design of Santa Maria are, as Morrogh states, an aesthetic continuance from Borromini and the Roman Baroque. However, the design also demonstrates an early stage of experimentation in Guarini's evolution as an architect and mathematician that he later demonstrates in the *Placita Philosophica* (1665), the *Euclides Adauctus* (1683) and the *Architettura Civile*

(1737).[43] There is a plethora of intricate knowledge pertaining to elliptical geometries in both treatises that demonstrate a clear, didactic connection between Guarini's mathematics and his architecture.

According to the *Euclides*, the eccentricity of an ellipse, which is caused by linear extension from the center, creates convexity and parallax by bending the periphery of the circle to reflect upon itself, like a lens (*si extra circulum sumatur punctum quodpiam, & ab eo ducantur rectæ, una per centrum transiens, reliquae aliae in causam peripheriam, vel convexam*). This convexity of the ellipse is created by the collapse of the peripheral concavity, due to the extension outward from the center of the circle (*extra circulum, & ex eo in concavum peripheriam cadens recta transeat per centrum*).[44]

Trattato III (*Della Ortografia Elevata*), Chapter II of the *Civile* discusses the use of curved lines in orthographic projection for building (*Del modo di piegare varie line curve necessarie all'ortografia*).[45] Observation seven describes the use of a wavy or 'rippled' line (*linea ondeggiante*) as it intersects a series of triangles. The accompanying diagram resembles the sinuous lines that run the course of Santa Maria's nave, intersecting triangles that extend from center-point to the outside wall of the church.

The following two demonstrations in Chapter II pertain to the use of parabolic and hyperbolic lines in orthographic projection. Guarini's earlier publication of the *Placita*, also demonstrates a connection between the hyperbola and the ellipse through a parametric

[43] Morrogh, "Pursuit of Originality," 6, f. 88. While Morrogh briefly introduces the importance of the *Euclides* as a widely known method of understanding Guarini's architecture, the article lacks research and translation of the document, and how it applies to Santa Maria della Divina Provvidenza.
[44] Guarini, *Euclides*, 72.
[45] Guarini, *Civile*, 118.

set of equations (*parametrum*) that ultimately leads to the theory of gnomonics that he uses in the design of San Lorenzo.[46]

The geometry involving ellipses and their function as a kind of 'lens,' as well as Guarini's development of orthographic projection, pertain to a principle in architecture, which he refers to as *permutando*, emphasizing the transformational nature of light in relation to movement in his system of geometry. It is this level of geometric intricacy that influences Guarini's architectural design—not only in terms of the solid structures that constitute the building itself, but the way in which the light of the sun interacts within the space.[47]

Morrogh's assertion that Guarini's introduction of this Baroque style was not as yet introduced to Portughese builders is well-founded. However, the importance of Guarini's development during this time lies not only what he is exporting what he gained from his experience as a seminarian at San Silvestro, but the knowledge that he gained through a first-hand exposure to Islamic and Mozaribic architecture that he ultimately brings home with him to northern Italy.

The Alcázar of Seville (c. 1360), the Mosque of Tremecen in Algeria (1082) as well as Cristo de la luz in Toledo (c. 390) were converted from mosques to churches after the conquest of Alfonso VI (1040–1109) in 1085. The Great Mosque of Córdoba underwent an expansion under the Umayyad Caliph al-Hakam II in 962 AD as part of the Sunni revival, intended to strengthen individualism, as well as diversity and unification.[48]

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[46] Guarini, *Euclides*, 416.
[47] Ibid.
[48] Yasser Tabaa, *The Transformation of Islamic Art during the Sunni Revival* (Seattle and London: University of Washington Press, 2001), 129–30.

The Moorish influence in Guarini's work exemplifies an understanding of architectural design which spans far beyond the confines of classical canons. The influence of the openwork dome is evident in the work of other architects in Piedmont, the northwest region of Italy where Guarini was most productive. Guarini's successor and pupil, Bernardo Antonio Vittone (1704–1770), designed many churches including the Tempietto a San Luigi Gonzaga (1760) and the Capella della Visitazione at Vallinotto (1738–1739), whose domes, like the one found above the presbytery at San Lorenzo, are in the form of a hexagram.[49] These churches, built after the completion of San Lorenzo, signify Guarini's influence within his own region through the integration of foreign styles and methods of construction. It is probable that Guarini received the commission while serving as the court engineer and mathematician for the Duke of Savoy in Turin because of their association with the Theatines, who had built a church upon the arrival of the Savoy Dynasty as early as 1648.[50]

Guarini's architectural influences also exist within an even broader framework. H.A. Meek, Elwin Robison, and Nino Carboneri elucidate the Gothic sources of Guarini's architectural works, in particular.[51] Robison, an architectural historian and structural engi-

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[49] Nino Carboneri, "Guarini ed il Piemonte" in *Guarino Guarini e l'Internazionalità del Barocco, Tomo Primo* (Torino: Accademia delle scienze, 1970), 356, 374; Florensa, "Mondo Islamico," 649.
[50] Ibid., 515.
[51] Meek, *Guarino Guarini*, 30, 53–7.; Elwin C. Robison, "Optics and Mathematics in the Domed Churches of Guarino Guarini," *Journal of the Society of Architectural Historians* 50, 4 (1991): 384, 399; The influence of the Gothic is spoken of by Nino Carboneri in the introduction of Guarini's *Architettura Civile*: "*La riserva più consistente nei confronti del Gotico concerne le proporzioni* [sic]*, che sono irriducibilmente in contrasto con le regole classiche. A questo punto l'Autore, per salvare la lore posizione prioritaria, pare sottintendere l'eventualità di un Gotico manieristicamente corretto: proposta non nuova nel corso del secolo*. Nino Carboneri, introduction *Architettura Civile*, by Guarino Guarini (Milano: Edizioni il Polifilo, 1968): xxix.

neer who studied Guarini's work during his travels in northern Italy as a Mormon missionary, writes of the architect's broad travels in Europe beyond Istria and the Apennine peninsula.[52]

It is not without consequence, however, that the two architectural systems presented within these geographic locations, French Gothic and Hispanomoresque, existed in historical simultaneity with the high point of Islamic architecture during the twelfth to the fifteenth centuries; the Gothic church, and a great deal of stylistic and structural similarity is presented within these two building systems, in comparing them to Guarini's architecture. The architectural element that must be noted, in particular, is the culmination of architectural evolution in the Islamic world which resulted in the *muqarnas* dome, whose influence is most plainly seen in the cupola of Guarini's Church of San Lorenzo.[53]

[52] E.C. Robison "Guarino Guarini's Church of San Lorenzo in Turin" (Ph.D. Diss., Cornell University, 1985), 1.

[53] For a concise history of the architectonic development of the *muqarnas* dome in Islamic architecture, see Yasser Tabbaa, *The Transformation of Islamic Art During the Sunni Revival* (Seattle and London: University of Washington Press, 2001): 137–40.; Siegfried Giedion, *Space, Time and Architecture; The Growth of a New Tradition* (Cambridge: Harvard University Press, 1967), 121–27; Florensa, "Mondo Islamico," 637–65; Meek, *Guarino Guarini*, 50–53; Robison, "San Lorenzo," v.; Carboneri, "Introduzione," xiii. "*A Torino il Guarini giungeva forte di un'esperienza complessa, arricchita da elementi romani, emiliani e siciliani, posti a confront con la cultura e con la tradizione architettonica francese (e forse anche iberica, se si accetta l'ipotesi, però non documentata, di un suo viaggio durante il soggiorno parigino), la quale d'altra parte era venuta in contatto con il Bernini e con altri artisti italiane per la fabbrica del Louvre.*"

Messina

In 1660, Guarini was appointed as professor of mathematics and philosophy at the archiepiscopal seminary in Messina, Sicily. During his tenure Guarini, published his first literary work, *La Pietà Trionfante*, a comedic tragedy that he began writing during his time in Modena.

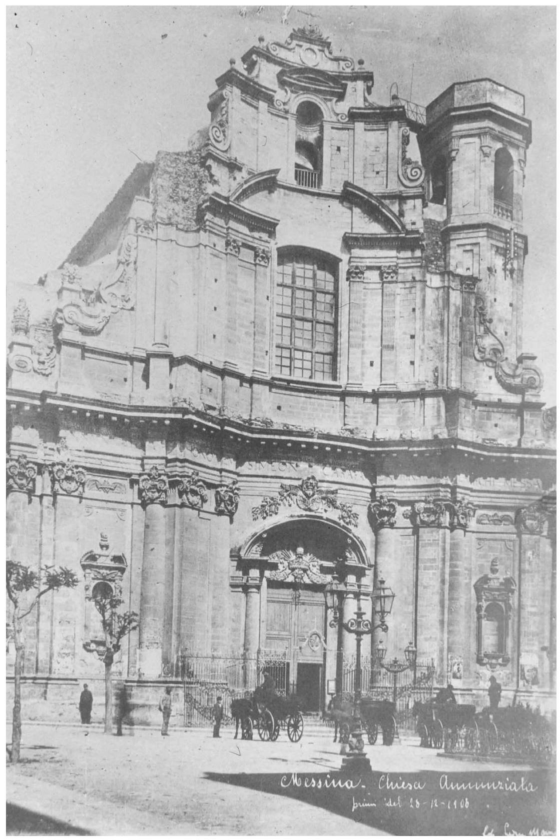
The importance of light in Guarini's *Trionfante* is evident within every treatise published thereafter. However, the meaning of light in these treatises, like everything in Guarini's mind is polyvalent, applicable to the designs of domes and their fenestrations as it is appealing to the political prowess of the monarchy and to theology and cosmology.

During his tenure as a professor at the seminary, Guarini was commissioned with four main architectural projects which he pursued over the next two years. The design of the façade of Santa Maria Annunziata and the adjacent Convento di San Vincenzo were interconnected projects. The Church of San Filippo and a church for the Padri Somaschi, a religious order founded in devotional service of the poor by San Gerolamo Emiliani (1486–1537) in 1532 were also commissions that he undertook during that time.[54]

The construction of Santa Maria Annunziata began in the decade that followed the arrival of the Theatine Order in Messina in 1607. The body of the church was nearing

[54] Meek, *Guarini*, 55. Meek notes that the inwardly concave form of the façade of this church is one evident comparison to the work of Francesco Borromini, and his Oratory of San Filippo Neri in Rome.; Nino Carboneri, "Introduzione," in Guarino Guarini, *Architettura Civile* (Milano: Edizioni Il Polifilo), xii. "*Nel 1660 è a Messina: non si hanno informazioni sul period intermedio, durante il quale dovette viaggiare molto, come si deduce dalla presentazione della* Pietà Trionfante, *pubblicata a Messina nel 1660, in cui è definite* '*Mercurio del Nostro Secolo*'" Meek, *Guarino Guarini*, 19. Meek also argues the fact that the only record of Guarini's arrival is due to the publication of Guarini's play, *La pietà trionfante*, which was written to be performed by the youths of the local seminary. He also is unsure of the 1660 date, stating that it may have been 1659 or 1660.

completion at the time of Guarini's arrival in 1660, at which point he was commissioned to design the façade and to draft plans for the convent. The Annunziata was consecrated on June thirteenth of that year by Simeon Carafa Roccella, who served as the Theatine Archbishop of Messina from 1647 to 1676.



8.
Santa Maria Annunziata, Messina, 1906
(Two years prior to the 1908 earthquake)

The practicing of building a seminary as an annex to a church was common practice among the religious orders of the seventeenth century because it served the dual function of providing a monastic setting for postulants and priests in formation, while serving as a local parish and encouraging the congregation in the discernment of religious vocations. Guarini's considerations in writing *La Pietà Trionfante* surely included the catechetical purpose of promoting vocations, presented in a theatrical fashion known uniquely to the Theatines.

The façade of Santa Maria Annunziata is tripartite; above the cornice of the first order, the shape of complex structure of lunettes and baroque foliations may be inscribed by an equilateral triangle. The lunette above the portal is echoed by another, above a large window in the clerestory and there is an octagonal-shaped campanile to the right. The concave/convex shape of the façade, along with the use of highly-ornamented volutes reflects the influence of Spanish *retablo*, as well as the concave/convex façade of Borromini's San Carlo alle Quattro Fontane (1638–41) in Rome.[55]

Several longitudinal churches built after Santa Maria Annunziata reveal the strong influence of a Guarinian aesthetic. The façade of Chiesa di San Matteo built in Lecce between 1667 and 1700 by Achille Carducci (1644–1712) has a lower order with a massive entry portal and apsidal niche that is convex, while the ornate central entablature of the upper order is concave, expressing a distinctive style indicative of the far southern reaches of the Salentine Peninsula.[56]

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[55] The association between these two architects is noted in particular by Hanno-Walter Kruft*, A History of Architectural Theory, from Vitruvius to the Present*, trans. Ronald Taylor, Elsie Callander and Antony Wood (London: Zwemmer, 1994), 105. "After a thorough study of Borromini's works, with which he became acquainted during his novitiate in Rome, Guarini approached architecture through mathematics, whose fundamental importance for architecture he repeatedly stresses."; Franco Borsi, "Guarino Guarini a Messina" in *Guarino Guarini e L'Internazionalità del Barocco* (Torino: Accademia delle Sciene, 1970), 74. Rather than Kruft's association of Guarini to Borromini, Borsi finds a connection between Guarini and Bernini, stating that the Annunziata is simple in proportion and therefore a derivation of the renaissance (*Proporzioni semplici, quindi, di derivazione rinascimentale — analoghe all'esperienza berniniana…*).; Werner Oeschlin, "Tra due fuochi: Bernardo Vittone e il 'Caso Piemonte'" in *Sperimentare l'Architettura: Guarini, Juvarra, Alfieri, Borra e Vitonne*, ed. Giuseppe Dardanello (Torino, Italia: Fondazione CRT Cassa di Risparmio di Torino, 2001), 289. "*Il più avanzato sviluppo dei pensieri guariniani e borrominiani, che fondava il canone architettonico su una complessa geometria di curve, poteva così essere giudicato solo come una fase epigonica, una conclusion del periodo 'barocco.'*"

[56] Kruft, *Architectural Theory*, 150.

In the Piedmont region, the influence of Guarini's design for Santa Maria Annunziata can be seen in the Chiesa di Santa Marta in Agliè designed by Costanzo Michela (1689–1754), which was under construction from 1740 until 1748.[57] Santa Marta's façade is influenced by Guarini's design for the Annunziata as well as the Palazzo Carignano in Turin. The door is flanked by two engaged pilasters; in the upper order there is a window behind a balustrade set in front of a deep stone arch. There are volutes on either side of the upper order that resemble those of the entablature at Carignano. The sides of the church synthesize the concave/convex forms of the Palazzo Carignano into an elegant, unified, sinuous sense of space.[58]

Guarini's influence can also be seen in the ichnography of Santa Marta's three-bay design, in which the first and third bay resemble the interpenetration of circle and triangle geometries in the worship space of the Chapel of the Holy Shroud. What Michela achieves at Santa Marta is the unfolding of the two interpenetrating geometries, so that the circle and the triangle mirror one another. Michela uses a structure commonly used for narthices during the Baroque period, placing it between the two reflecting bays rather than at the entrance.[59]

Accordingly, the southern architects bear the mark of Guarini's influence in the buildings that he designed there. His influence can be seen in the Chiesa della Concezione a Montecalvario built by Domenico Antonio Vaccaro (1678–1748) in Naples between 1718

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[57] Richard Pommer, "Costanzo Michela and Santa Marta in Agliè: A Guarinesque Rarity" in *The Art Bulletin* 50, 3 (1968): 171.; Richard Pommer, "A Note on Santa Marta in Agliè" in *Guarinio Guarini e l'Internazionalità del Barocco* (Torino: Accademia delle Scienze, 1970), 385.
[58] Matteucci, *Settecento*, 191–93.
[59] Pommer, "Santa Marta," 386. Pommer also finds an influence of Guarini's Chapel of the Holy Shroud in the design of Santa Marta, but states that the similarity pertains to the design of the piers in the first bay, and with Santa Marta's influence on Vittone's unexecuted plan for Santa Chiara in Alessandria (c. 1738–1740).

and 1724. The designs for the vaulting of the vestibule create a sense of tension and elasticity because of their form and ornamentation that emulates those found in the Palazzo Carignano (begun in 1679). This design also bears the influence of Vaccaro's Bavarian contemporary Johann Michael Fischer (1692–1766).[60] The Guarinian influence in the work of Carducci and Michela are a sign of the architect's presence in the south and north of the Italian peninsula, an influence drawn from Guarini's immersion in the work of Bernini and Borromini during his time at San Silvestro in Rome.

The presence of Italian architects at the forefront began to decline from around the time of Guarini's death in 1683 until the 1730s, when Bernardo Antonio Vittone (1704–1770) began introducing Guarinesque forms into his designs. The chapels of the Concorso Clementino of the Accademia di San Luca in Rome (1713), Santa Chiara in Alessandria, which is unrealized, and the lower church of the Basilica of the Sacro Monte in Varallo (1735–36) are examples of the evolution of architectonic forms from Guarini to Vittone.[61]

In the work of Guarini, Carducci and Michela, the use of concave/convex surfaces is brought about through transposing and synthesizing Euclidean forms. The architecture of the seventeenth century involves the reciprocation of Euclidean elements, as in the façade of the Annunziata and at San Matteo that create an opposition of form, like the intersection of two parabolae formed by the movement of the directrix. The genesis of surface to dimensional form exists in the evolution from the Annunziata to the domes of Sainte-Anne-la-Royale and San Lorenzo. As in the allegory presented in *La Pietà Trionfante*, the intersection of forms symbolically represents light as the generative element of creation

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[60] Matteucci, Anna Maria. *L'Architettura del Settecento* (Torino: Unione Tipografico-Editrice Toriniese, 1988), 121–22.

[61] Pommer, "Costanza Michela," 171. Pommer suggests that it was most likely Giovanni Battista Morondi that started the project at Sacro Monte in Varallo.

itself, another concept presented by Guarini in the *Placita*, as well as the *Euclides Adauctus*.[62]

The church of Santa Maria Annunziata was destroyed by a massive earthquake in 1908 along with the cities of Messina and Reggio Calabria. Allied forces invaded the city of Messina during Operation Husky in 1943 with the intention of liberating Sicily from the fascist grip of Hitler and Mussolini, but at the cost of levelling anything that had been rebuilt since the earthquake. The destruction of Messina by the violence of nature and war has obstructed our ability to form a solid historiography of Guarini's Sicilian journey or to recreate the Annunziata from the remaining stone fragments stored today within the Museo Nazionale.[63]

No construction record exists for Guarini's other commissions, including the Church of San Filippo and the Church of the Padri Somaschi, although he drafted a number of plans for both projects. Nevertheless, Guarini's time appears to be consumed with the numerous commissions with which he was granted until the beginning of 1662.

Upon the arrival of spring, Guarini received word that his mother was gravely ill and swiftly departed from the island of Sicily to Modena to stay with her at the end of her life. He remained there for several months while also drafting plans for the façade of the Theatine church of San Vincenzo in Modena, but the project was never executed.[64]

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[62] Henry Millon, "La Geometria nel Linguaggio Architettonico del Guarini" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademia delle Scienze, 1970), 47. "*...Guarini trasforma elementi decorativi in elementi funzionali e viceversa, al fine di raggiungere quel risultato figurativo che accentua il quasi umano rapporto tra le masse e gli spazi, e tra gli elementi e la loro relazione con la luce simbolicamente interpretata come elemento generatore della vita.*"

[63] Borsi, "Guarini a Messina," 71.; Ibid., 73. "*...pochi frammenti marmorei raccolti nello spiazzato del Museum Nazionale.*"; Carboneri, "Introduzione," xii.

[64] Carboneri, "Introduzione," xii. The possibility that Guarini's designs for the Church of San Filippo and the Church of the Padri Somaschi may have been completed at a later date is suggested in the introduction of the 1968 edition of the *Architettura Civile* by Carboneri.

Paris

Guarini was reassigned to Paris in October of 1662, where he took up the building of the Church of Sainte-Anne-la-Royale, originally commissioned to Antonio Maurizio Valperga (1605–1688). The building of Sainte Anne signifies the growing presence of the Theatine Order in Paris during the time of its commission and involves the complex interplay between the French monarchy and the Theatines. Paris was also undergoing a period of construction during this time that involved a number of powerful international architects.

The Theatines first established themselves in Paris prior to 1615, during the shift of power from the French rule of Cardinal Richelieu, Armand Jean du Plessis (1585–1642) to the rule of the Italian Cardinal, Jules Raymond Mazarin (1602–1661) in 1644.[65] Cardinal Mazarin had a refined sense of taste, suited well for the sumptuous sophistication of Theatine art and architecture and it was through Mazarin that the knowledge of their craft became known to the patrons of France. In May of 1647, Mazarin acquired a property close to where the Theatines would make their new home in Paris.

The following year, the Duke of Verneuil (1601–1682) obtained permission to establish the place where Sainte-Anne-la-Royale would be built by way of a negotiation with the abbot of Saint-Germain-des-Prés on a prominent location along the quay of the Seine facing the Louvre.[66] On the eve of the feast of Saint Anne, the church fathers recall the

[65] Alan Boase, "Sant'Anna Reale" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademia delle Scienze, 1970), 345.
[66] Ibid., 346.

visit of the young Louis XIV to celebrate the patronage of the mother of Mary in the building of the new church.

The Theatines were commissioned for the construction of Sainte-Anne-la-Royale by Cardinal Mazarin (1602–1661). Mazarin left 300,000 livres upon his death a year prior.[67] Several architects were in Paris at the time whom the Cardinal had at his disposal, including Gianlorenzo Bernini (1598–1680) who was commissioned to rebuild the Louvre by Paul Fréart de Chantelou (1609–1694), the young Christopher Wren (1632–1723), who was in Paris studying French architecture, as well as François Mansart (1598–1666) and Louis Le Vau (1612–1670).[68]

Mazarin initially commissioned Valperga for the project of Sainte Anne because of his expertise as a military engineer with whom the Cardinal had worked in the Piedmont region.[69] His initial design was for an oval-shaped church with a cross vault and a dome over the center of the nave that faced the Seine. The design was accepted by the Theatine fathers that were appointed to the project five months after the death of Mazarin. The foundation trenches were under construction by November 8, 1661. However, Valperga was devoted to another commission granted by Louis XIV (1638–1715) to design the fortifications for the town of Brissach near Colmar in the northern mountainous region of Alsace.[70]

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[67] Ibid.; Rudolf Wittkower, "Introduzione al Guarini" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademica delle Scienze, 1970), 23.

[68] Ibid., 22–23.; Susan Klaiber, "Guarini e Parigi: interscambi culturali e critici" in *Sperimentare l'Architettura: Guarini, Juvarra, Alfieri, Borra e Vittone*, Giuseppe Dardanello, ed. (Torino: Fondazione CRT Cassa di Risparmio di Torino, 2001), 16.

[69] Ibid., 18.

[70] Meek, *Guarini*, 27.; Augusta Lange, "Disegni e Documenti di Guarino Guarini" in *Guarino Guarini e l'Internazionalità del Barocco* (Turin, Italy: Accademia delle Scienze, 1970), 109. "*Valeperga occupato in quel tempo (e lo sarà fino al 1670) nella fortificazione della famosa città di Brissach sul Reno, per il re di Francia.*"

Guarini received word from the Father General of the Theatine Order to take up the project in place of Valperga and left immediately thereafter for Paris. He thought poorly of Valperga's design—that it would be dark, narrow and lacking in unity—and presented a new design for Sainte-Anne-la-Royale in the shape of a Greek cross. He widened the four arms of the cross, creating an elegant symmetry of space in harmony with the large central dome.

There are four massive piers at the crossing, set at a diagonal at the top of which is a continuous frieze, articulated by engaged pilasters and a double cornice. Above this is the level of the clerestory, where large fenestrations are set within two semicircular arches which hang below the square structure of the crossing. A gallery is set around the perimeter of the space above the crossing with pedimented windows within arches separated by double colonnades.

At the top of this space is the drum of the dome. The base of the *cupolino* is octagonal with a fenestrated lantern above it.[71] The design of the dome is formed by the symmetry of overlapping quadrilaterals, which create the illusion of interlaced arcs within the three-dimensional structure. As in San Lorenzo, the design of the dome and gallery above the clerestory is intended to allow for the greatest potential of light to enter the church.

An ichnographic comparison between Valperga's original plan and Guarini's design demonstrates a continuation of the project originally set forth. Guarini's improvisation appears to be within the boundaries of Valperga's design: the circular crossing in place of

[71] Mario Passanti, *Nel Mondo Magico di Guarino Guarini* (Torino: Toso, 1963), 76–77.

Valperga's ellipse, the shifting of the size and structure of the piers, allowing for a greater expanse of space and the diffusion of light into the sanctuary space.[72]

The recommissioning of Sainte Anne to Guarini was a departure from Valperga's design rather than a revision.[73] Guarini abandons Valperga's Borrominesque sensibilities for a taller, more massive church that incorporates Baroque elements within the foundation of Gothic construction in the use of attenuated verticality and interlaced vaulting within the dome. The height and spatial distribution of pilasters within the lower order of the church, the columns within the drum of the dome and the pointed arches of clerestory windows that comprise the vaulting on either side of the nave, resonate the proportions of French Gothic architecture in which Guarini immersed himself during his tenure in Paris.

The religious historian Raymond Darricau (1923–1992) published a book concerning the history of the Theatine Order in Paris (*Les Clercs Réguliers Théatins à Paris*, 1954), in which he briefly discusses the formation of the Theatine chapter house in 1644, the funding of the project by Mazarin and the history of Sainte Anne during the nineteenth century, a period in which the Theatine Order was suppressed under the reign of Napoleon

[72] Ibid., 21. "*Guarini smussò gli enormi pilastri della crociera di Valperga in un modo che richiama I pilastri angolati dell'architettura gotica, come quelli che poteva vedere nella crociera di Saint-Denis; quindi ne feceproseguire gli stessi profili angolati negli arconi, accostandosi più all'intersezione lineare delle volte gotiche che al tradizionale sviluppo di un arco intradossato.*"

[73] Ibid., 18–19. Klaiber argues that Guarini incorporated Valperga's original design into his own in order to respond to the necessity of the Theatines to assimilate within French culture. However, the departure from his original design is profound and demonstrates Guarini's ability to assimilate the architectural knowledge of the culture in which he resides; a method of didacticism that reaches beyond the necessity for political or sociocultural assimilation.

Bonaparte (1769–1821).[74] Darricau states that the changes in Valperga's design implemented by Guarini were accepted by the general of the Theatine Order. However, a number of factors ultimately impeded the lengthy construction and completion of the project.

9.
Sainte-Anne-la-Royale, elevation and plan

The construction of Sainte Anne began on the twenty-eighth of November, 1662 in a prominent site facing the Louvre on the *quai* of the Seine. Four years into the construction, both transepts of the church were nearing completion. Financial strains, as well as monetary and material resources became increasingly irregular, putting the project in jeopardy. In a fit of resignation, Guarini sharply accused the superior of the Theatine Order of mishandling resources and abandoned the project, leaving swiftly for Turin in the autumn

[74] Lange, "Disegni e Documenti," 103.; Raymond Darricau, "Les Clercs Réguliers Théatins à Paris" in *Regnum Dei, Collectanea Théatina* (Rome: San Andrea della Valle, 1954), 1–6.; Albert Boime, *Art in the Age of Bonapartism, 1800–1815* (Chicago: University of Chicago Press, 1990), 77, 83, 270.

of 1666. Although construction continued in Guarini's absence, the resources originally provided by Mazarin's endowment were completely exhausted by 1669.[75]

Susan Klaiber's research into the drawings of Lieven Cruyl (c. 1640–c. 1720), who visited Paris in the late 1680s, reveals that the church had a temporary conical dome, which was eventually replaced by a high-pitched roof between 1714 and 1720.[76] According to Augusta Lange's research, a wood model of Sainte Anne existed until at least 1787 in the Theatine Library of Guarini's original design, prior to the completion and alteration of the construction revealed by Lieven's drawings.[77]

The construction of Sainte-Anne-la-Royale proceeded under the direction of Nicolas Liévain but at a much slower pace until 1720. The orientation of the building was changed, placing the church on a north-south axis. The main altar was constructed and positioned anterior to the presbytery under the archways of the lower interior and clerestory.[78] Sainte-Anne-la-Royale was completed in 1720, although Guarini's vision of the final church was never brought to fruition, including the interlaced dome and an undulating façade, similar to that which is present in his later design of the Palazzo Carignano. The church was demolished in 1823 during the Bourbon Restoration that followed the reign of Napoleon as part of their effort to reconstruct the symbols of the *Ancien Régime*.[79]

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[75] Lange, "Disegni e Documenti," 103.; Ibid., 113. "*I Registri Capitolari di Parigi, dopo la partenza di Guarini, rivelano tuttavia che i Teatini si trovavano ad affrontare notevoli difficoltà finanziare. Oltre alle spese fatte per gli acquiti di terreni, poichè questi dipendevano dall'abbazia di St. Germain-des-Près, per ogni uomo 'vivant et mourant' su tali fondi erano dovute alla morte 3600 livres; che capitalizzate ammontavano a un debito di 145.250 livres verso l'abbazia (Capitolo del 4 novembre 1667).*"; Meek, *Guarini*, 61.
[76] Susan Klaiber, "A Lantern Aloft: Lievain Cuyl Records Guarini's Sainte-Anne-la-Royale," in *Susan Klaiber, Architectural Historian*, November 28th, 2014, https://susanklaiber.wordpress.com/tag/sainte-anne-la-royale/.
[77] Lange, "Disegni e Documenti," 110. "*Del progetto di Guarini fu eseguito allora — probabilmente per quell'occasione — un modello di legno che nel 1787 esisteva ancora nella Biblioteca dei Teatini, ma che non era più stato tenuto presente dal Lievain, quando nel 1720 terminò e trasformò completamente la costruzione.*"
[78] Ibid., 104.
[79] Rudolf Wittkower, *Art and Architecture in Italy 1650–1750* (Singapore: Penguin Books, 1958), 30.

During the construction of Sainte Anne la Royale, Guarini was appointed as a lecturer of theology at the Theatine School in Paris.[80] The position at the Theatine School served him well, as it presented the opportunity to complete the research that he started during his exile on the *Placita Philosophica*. The treatise was first published under the title *Placita Philosophica, Physics rationibus, experientijs, Mathematicisque figuris ostensa* in 1663, as a volume that contained most, but not all of the chapters of the treatise. The *Placita Philosophica* was ultimately published in its entirety in Paris by Dionysium Thierry on the thirteenth of January, 1665.[81]

The *Placita Philosophica* is a masterpiece of philosophy, establishing Guarini's complex system of thought. The 868-page treatise is divided into seven books: *Praeparatio ad Logicam* (A Preparation According to Logic), *Physicae* (Physics), *Libros de Caelo et Mundo* (Heaven and Earth), *De Luce* (On Light), *De Generatione e Corruptione* (On Generation and Corruption), *De Viventibus* (On Life) and *Metaphysica* (Metaphysics).[82]

The progression of chapters in the *Placita* echoes Guarini's training as a seminarian at San Silvestro as well as the course of the six days of creation, known since the early church as the *Hexameron*; the seventh chapter on metaphysics represents the culmination of the Sabbath.[83] For Guarini to base his own epistemology on the Hexameron reflects the

[80] Lange, "Disegni e Documenti," 110. "*...gli diedi l'incarico di scrutatore dei novizi e professi; il 29 agosto 1664 lo nominò lettore di teologia.*"
[81] Silos, *Historiarum Regulorum*, 572. "*Typis verò Parisiensibus vidit insigne opus Lucem, cui titulis:* Placita Philosophica, Physicis rationibus, experientijs, Mathematicisque figuris ostensa. *Parisijs apud Dionysium Tuierry 1663.*"
[82] Capucci, "Letterato," 78. "*Intenti analoghi mostrò nell'opera sua più ponderosa e faticosa, i* Placita Philosophica*, nella quale però di rado lo confortò quella chiarezza e contrassegna l'*Architettura Civile*. La 'tecnica' dei* Placita*, didascalica e scolastica, si articola in uno schema di enunciazioni, obbiezioni, e risposte, che livella ogni argomento e mostra l'incapacità del Guarini di enucleare i problem più importanti dalla farraginosa materia trattata.*"
[83] Silos, *Historiarum Regulorum*, 572. "*Typis verò Parisiensibus vidit insigne opus Lucem, cui titulis:* Placita Philosophica, Physicis rationibus, experientijs, Mathematicisque figuris ostensa. *Parisijs apud Dionysium Tuierry 1663.*"; Carboneri, "Introduzione," xii. Guarini's lectures at the Theatine School were also based on

deeply symbolic, devotional nature of exegetical writings that synthesize and expound upon the knowledge of the Bible.

The first book's demonstration of the importance of logic as a preparatory course of instruction (*Praeparatio ad Logicam*), exemplifies the influence of Guarini's education at the Theatine seminary of San Silvestro. *Expensio I*, On Limit (*Quid sit Terminus*) defines the three operations of the intellect; those being the auditory understanding of simple concepts and the extrinsic opposition and acceptance of intellectual ideas; the function of judgment in what we understand; and discursive reasoning which may to some extent be deductive.[84] The limit, according to Guarini, or the ultimate end of knowledge (*scientia*) is the primary apprehension of that which is initially understood by the mind (*terminus ergo est ille, qui primò per apprehensionem primam concipitur*).[85] The end of knowledge is essentially the beginning; the limit is the ultimate *a priori*. The voice of human intelligence is not the end of being (*scilicet in voce, homo, hominem non esse terminum*), rather to be human, in and of itself, is being and existence (*esse ipsius hominis*).[86]

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his research in physics and metaphysics that is included in the *Placita*, which he began developing during his time as a professor in Modena and Messina. "*È del periodo parigino, durante il quale insegna teologia, l'edizione dei* Placita Philosophica (1665), *che riassumono i risultati degli studi e delle lezioni di Modena, Messina e Parigi, nell'ambito della fisica e della metaphysica.*"

[84] Capucci, "Letterato," 1. "*Notandum 1. tres esse intellecutus operationes: Prima apprehensiva vocatur, & haec simpliciter rem apprehendit, & ab extrinseco obiecto assumens in intellectu ponit. 2. Operatio iudicat de re apprehensa, scilicet, an bona, vel mala sit, an talis, vel talis sit, & haec affirmat, vel negat. 3. est Discursus, qui à re iudicatâ aliquid deducit…*"

[85] Ibid.; Aristotle, *Metaphysics*, trans. Richard Hope (New York: Columbia University Press, 1952), 112. "'Limit means the last point of anything; that is, the first point beyond which it is not possible to find any part, and the first point within which all the points are. It means the form, whatever it may be, of a spatial magnitude or of what has magnitude. It means also the end of anything, that to which, not from which, a movement or action proceeds; but sometimes it means both beginning and end. It means, finally, the wherefore, the primary being, the 'what' of anything; for these are the limits of knowledge, and, if of knowledge, then also of things. Thus, it is evident that 'limit' means as many different things as does 'beginning,' and even more; for a beginning is in a sense a limit, but not every limit is a beginning."

[86] Ibid. "*Terminus ergo est ille, qui primò per apprehensionem primam concipitur…Ego verò existimo terminum non esse vocem, seu verbum litteris, syllabisque compositum, quod voce sonamus: sed esse illam vim, quam habet repraesentadi illum conceptum, qui per primam apprehensionem in mente nostrâ habetur; scilicet in voce, homo, hominem non esse terminum; sed illud, quod per vocem hominis intelligitur, scilicet esse ipsius hominis: hoc posito, sit.*"


Collegij S. J. Monac.

PLACITA
PHILOSOPHICA
R. P. D.
GVARINI GVARINI
MVTINENSIS
CLERICI REGVLARIS,
Vulgò Theatini,
SACRÆ THEOLOGIÆ PROFESSORIS,
PHYSICIS RATIONIBVS, EXPERIENTIIS, MATHEMATICISQVE figuris ostensa: quæ sicut sacræ Theologiæ leniùs obsequuntur, ita à principiis aliarum scientiarum obstinatiùs non abhorrent: simulque Vniuersæ Philosophiæ Theses felici pede percurrunt.
CVM DVOBVS INDICIBVS,
Altero Disputationum; Rerum altero.

PARISIIS,
Apud DIONYSIVM THIERRY, viâ Iacobæâ, ad insigne Ciuitatis Parisiensis.

M. DC. LXV.
Cum Priuilegio Regis, & Superiorum Permissu.

10.
Placita Philosophica, 1665

The first Disputation, on Whether Logic is Knowledge (*An Logica sit Scientia*), states that reason is that which allows the unification of universal objectivity (*ratio est, quia habet unicum obiectum universale*). The elements of this objectivity become a body put into motion; the physics of the universe (*alia scientia corpus sub ratione mobilis; nisi*

Physica), like shafts of corpuscular sunlight penetrating San Lorenzo's fenestrated dome, as the church circumnavigates our closest star from its terrestrial axis.[87]

Book Two pertains to physics (*Physicae*) and how they pertain to the *materia prima*, substantial form, total composition, nature and art, causes, actions, time and duration, infinity, location and void. Guarini conveys the importance of delineating between the philosophy of physics, mathematics and metaphysics; physics pertains to the perfection of matter (*physicam à materiâ perfectionis*), while metaphysics pertains to matter of abstraction (*metaphysicam ab omni materiâ esse abstractam*) and mathematics pertains to the quantification of matter (*mathematicam à materiali quantitatis*).[88]

The philosophical division between perfection, abstraction and quantification, clarifies these three disciplines by creating a contradistinction, yet their connection is universally apparent as well. Applied to architecture, the perfection of form is dependent on this method of abstraction as well as quantification, infinitude and mensuration. As infinity is immensurable, quantification becomes possible primarily through the perfection of matter, brought about by the connection of form to universality.

The first universal causation is the *materia prima*. As the syllogistic trinity exists between God as both Father and Son, the *materia prima* exists in the form of three principles: the transmutation of natural bodies according to their first and preeminent cause; this transmutation interacts and envelops existence in a manner that is not always accessible to

[87] Ibid., 15.

[88] Ibid., 180. "*Aliqui dividunt Philosophiam in Physicam, Mathematicam, & Metaphysicam, desumentes divisiones rationes à diversa abstractione, cum Arist. 2. Phys. à tex. 16. usque ad tex. 18. & 6. Metaph. cap. 1. & 1. de anim. tex. 17 it ut velit Metaphysicam ab omni materiâ esse abstractam; Physicam à materiâ perfectionis, nempe eius, que spectat ad essentialem rei constitutionem; Mathematicam à materiali Quantitatis.*"

the senses; and while the *materia prima* is not dependent on physical considerations, it is the root, foundation and therefore, the source of everything sought in nature.[89]

The *Placita Philosophica* predates the publication of the *Civile* by over seventy years. It is a system of thought that develops into Guarini's *epistêmê* that guides the development of his architectural craft (*technê*) throughout his life. Guarini's theory of architecture is ever present within this treatise. What may be clearly seen in connection to the *Placita*, given the timeframe of the treatise, is the burgeoning development of the history of science along with the history of architecture.

The philosophical system of the *Placita* (logic, light, space, anatomy, the heavens and the metaphysics of being) is interpreted within a didactic, pragmatic and structural framework in Guarini's architectural production up to this point, including the design of Saint-Anne-la-Royale and then in San Lorenzo, the project for which he would be commissioned in 1668, three years after the publication of the *Placita*.

Paris has an important association with a number of other important philosophers, including René Descartes (1596–1650), who died in Stockholm, Sweden just twelve years prior to Guarini's arrival.[90] Although it has been noted that in 1663, a year after Guarini's arrival, Pope Alexander VII officially put Descartes on the list of prohibited books, this does not for any reason mean that Guarini did not read or have access to his works. Johannes Kepler (1571–1630) is another scholar during Guarini's time whose work was also banned by the *Index Librorum Prohibitorum*; however, Kepler is, indeed, an important and

[89] Ibid., 183.
[90] Oeschlin, "Tra due fuochi," 296. Descartes influenced the theory of architectural design among a number of seventeenth-century architects, including Ermenegildo Pini: "*Fu un ecclesiastico milanese, Ermenegildo Pini, a unificare i punti di vista della discussione in modo provocatorio. Nel 1770, in una discussione fittizia riguardante la costruzione delle cupole, Pini mise a confronto l'architettura di Borromini, come anche i contributi 'tecnici' e le capacità dell'architetto criticato in altre occasioni, con l''ammirabile sistema' di Descartes.*"

integral part of Guarini's studies, whose theories are spoken of extensively in the *Euclides* as well as the *Cælestis*.[91]

Several other astronomers contemporary to Guarini's time are also mentioned in the *Cælestis*. The French astronomer and Catholic priest Ismaël Bullialdus (1605–1694) is another scholar with whom Guarini might have been associated with in Paris, as Bullialdus returned there at the end of his life to retire at the Abbey of St. Victor.[92] Bullialdus is also mentioned numerous times in Guarini's *Cælestis* in conjunction with Kepler, particularly in *Tractatus VIII*, which discusses the eccentricity of planetary orbits. The Italian astronomer Giovanni Domenico (Jean-Dominique) Cassini (1625–1712), who moved to Paris seven years after Guarini's arrival, is also discussed extensively within the lines of Guarini's work. One other interesting reference made in Guarini's *Euclides* is that of Mercury's transit over the sun in 1661, which was also witnessed and recorded by the astronomer Christiaan Huygens (1629–1695).

Guarini's association with the physician and anatomist Claude Perrault (1613–1688) also reflects an influence on Guarini's ideas on aesthetics and opticality. Guarini's relations with Perrault also included associations with architects who would soon become involved with the *Académie royal d'architecture* after its founding in 1671. A renewed

[91] McQuillan, "Fortification," 615. "In my doctoral thesis, I stated that Guarini's arrival in Paris in the 1660s was subject to two possible and linked interpretations. One was a genuine denunciation of the seventeenth century's increasing involvement with the mathematisation of nature, a task that was denied in traditional philosophy, even in the face of Pythagorean and Platonic encouragement. Classical and Scholastic philosophy held that causation was best accounted for only in dialectic and not mathematically, in which no causation could be divined. The second attitude that Guarini adopted was a rejection of the *méchanisme* of the Cartesian school, after Descartes and the others were added to the Roman Index of Prohibited Books, as well as the current tribulations of the French Jansenists, easily seen as a revolt against religious orthodoxy and not far from the rationalists among the Cartesian school. Guarini was above all orthodox, and stood on time-honoured principles that the Church espoused with maximum authority."

[92] James P. McQuillan, "Geometry and light in the architecture of Guarino Guarini" (Ph.D. Diss., University of Cambridge, 1991), 14. McQuillan also mentions Guarini's association to both Descartes as well as Bullialdus.

interest in the beauty of the Gothic church and the practice of structural corrections due to optical principles developed out of their academic camaraderie. It has been theorized by Robison that Perrault's experience as a doctor and Guarini's knowledge of engineering coincided in their studies to implement the correction of visual distortions within architectural design.[93]

Guarini's involvement in the building of Sainte Anne continued until the twenty-seventh of September, 1666. A letter from the thirteenth of October, written by Padre Premoli, documents that Guarini and his colleague Padre Fardella of the Theatine School had returned to Italy.[94] Guarini's reasons for abandoning the project are not known, but given the level of demand for his high level of expertise as a professor and architect, he may have moved on to the next project at the demand of his patrons, leaving Sainte Anne for someone else to finish.

[93] See Robison, "Optics and Mathematics," 398–401. For further discussion concerning Perrault, including his position as a *moderne* in architectural theory, and his euhemeristic viewpoints concerning architecture, see: Robin Evans. *The Projective Cast* (Cambridge: Massachusetts Institute of Technology, 1995), 268–9.
[94] Lange, "Disegni e Documenti," 111. "*Nel Capitolo seguente del 13 ottobre in cui si dà licenza al P. Premoli di ritirarsi in Italia prima della cattiva stagione — è scritto: 'li Padri D. A. Fardella e D. Guerino Guerini sono partiti per l'Italia'. La notizia è ripetuta il 15 ottobre, e il 19 novembre, ad ambedue si sostituiscono altri lettori di teologia. In seguito di lui non si fa più parola, e manca ogni cenno ai motivi per i quali egli abbandonò la fabbrica della chiesa e il convento.*"

Turin

Guarini's longest and most fortuitous period began upon his arrival in Turin in the late autumn of 1666, fifteen to twenty days after departing from Paris.[95] His presence in Turin was requested by Carlo Emanuele II, Duke of Savoy, for his architectural expertise and erudition, by which he would take up a number of projects in Turin and the surrounding region. These architectural endeavors, along with the publication of six more treatises, determine the course of Guarini's work for the next seventeen years until his death in 1683.

Shortly after arriving in Turin, Guarini was invited by the Theatines of Vicenza to submit a design proposal for the rebuilding of the church of San Stefano in Nizza Monferrato, about sixty kilometers southeast of Turin. Guarini's design for the project and the inspection of the site were submitted *in absentia* because of time constraints and preoccupations with projects that were already underway in Turin.[96]

The Savoy Dynasty held possession of the city of Nizza at that time and planned to finance Guarini's project in full. The dynasty's military front was also quickly expanding as they declared war in Flanders, Douai in the north of France, at Oder Narden in Germany and in Italy at Borgagna, Greci and against the Dola Family in Messina, Sicily. The Savoy conquest also reached the Netherlands, attacking the regions of Tongeren and Maastricht,

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[95] Ibid., 116.; Nino Carboneri, "Introduzione" in *Architettura Civile*, ed. Bianca Tavassi la Greca (Milano, It.: Edizioni di Polifilio, 1968), xiii. "*Nel 1666 giunge a Torino: qui l'errabondo Guarini inaugural un period relativamente lungo e fortunato di attività, tanto nel campo dell'architettura quanto in quello degli studi teorici.*"

[96] Nino Carboneri, "Introduzione," xiii. "*L'arrivo a Torino si riteneva conseguente ad una visita a Nizza per i progetti della Chiesa di San Gaetano; più probabilmente il sopralluogo fu compiuto già da Torino, ove venne chiarmato direttamente da Parigi per la fabbrica della Chiesa di San Lorenzo (pure dei Teatini), che si trascinava da tempo.*"

Rimburg, Doesburg, Creusot and Bommel. However, the advancement of their ranks into the low countries placed them in direct conflict with France, a formidable opponent whose lieutenant general is spoken of by Guarini as a terrorizing force who claimed victory over the Savoy in the brief course of a year.[97]

The dynasty's conflict with the French hindered the plan for building San Gaetano and Guarini's design was ultimately rejected. It was not until the eighteenth century that the project of San Gaetano was given to Vittone, who built the church on a different site in the city of Nizza.[98] As with many of Vittone's commissions, he appears to pick up where Guarini left off, reinventing the geometric complexity of Guarini's baroque during the rococo of the eighteenth century.[99] In Vittone's San Gaetano, the vaulting of Guarini's original design is brilliantly reworked to accentuate the concave/convex formalism used in the design of façades, but to an even greater degree of complexity.[100]

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[97] Guarini, *Fortificatione*, 2. "*Che saggio di virtù militare non pompeggio nel Conte di Soisons suo glorioso Padre? Mommedi, Mardic, Doncheren, nelle prime guerre di Fiandra; indi nelle seconde Douai, & Odenarden, & in Borgagna, Grei, e Dola, da lui principalmente Generale delle Guardie Sguizzare del Rè Christianissimo si piansero fatte captive. Nelle guerre d' Olanda Tongre Masec, Rimburga, Doesburgo, Creusoot, e Bomel, sopra ogn'altro lo videro aventarsi, qual fulmine di guerra, contro di loro: e Tenente Generale di tutto l'Esercito Francese, in un sol'anno, hora con il terrore, hor con la forza, le foggiogò, e le vinse.*"

[98] Meek, *Guarino Guarini*, 139–40.

[99] Oeschlin, "Tra due fuochi," 285. "*Per Wittkower Vittone è un 'genio ossessionato.' Una definizione che ricorda molto le considerazioni, già di per sé eccessivamente mistificate, degli storici dell'arte su Borromini e Guarini, divenute* topoi *ripetuti circa la figura dell'artista in epoca barocca. Infine Wittkower chiude le sue considerazioni su un arco di trecento anni di evoluzione storica dell'architettura con un rinvio all'interesse di Vittone per le armonie musicali: 'il principio e la ine si incontrano.' La logica della storia dell'arte e dello sviluppo stilistico, assieme a una concezione limitativa dell'epoca barocca come fenomeno in sé concluso, hanno il sopravvento su una visione non preconcetta di un'architettura in rapido e continuo sviluppo nel corso del XVIII secolo.*"

[100] Pommer, "Costanzo Michela," 176.

11.
Church of San Gaetano, Nizza, (unrealized)

Shortly after Guarini initially submitted plans for San Gaetano, he was commissioned by Carlo Emanuele II, Duke of Savoy to write the *Trattato di Fortificatione* (Treatise on Fortification). He dedicates the treatise to Prince Ludovico Giulio di Carignano, emphasizing the need for the prince to support his father, Prince Louis Thomas, Count of Soissons in his military endeavors. The purpose of the treatise is to instruct Ludovico in Euclidean geometry and to facilitate the development of a more precise military strategy through the use of mathematics and fortification systems.[101] While the written manuscript of the *Trattato* was most likely used by the prince and the Savoy dynasty, it would not go to press as a printed publication for another ten years.

[101] Guarini, *Fortificatione*, "*Che saggio di virtù militare non pompeggio nel Conte de Soisons*.; James McQuillan, "The Treatise on Fortification by Guarino Guarini" in the *Nexus Network Journal* 16 (2014): 619.

The fundamental importance of light (*in principio creavit*) is introduced at the beginning of the *Trattato*; Guarini's poor and humble work (*operetta mia di fortificatione povera e dimessa*) once again extends into such light (*esce alla luce*).[102] Guarini's Treatise on Fortification establishes a connection between geometric structure and rays of light that is originally presented in the *Optica et Catoptrica* of Euclid (fl. 300 BC). The *Optica* states that light is related to geometry as solid as iron (*omnem lucem secundum rectas lineas ferri*). Euclid's ancient theory of optics presents the radical idea that shadow and light create solid projective geometries (*umbras è corporibus proiectas*); a theory which lends itself to the idea that architecture can be designed by the light of the sun and the geometries created by the projection of its rays.[103]

Guarini states that his primary goal in writing the Treatise on Fortification is his dedication to instruct prince Ludovico in the elementary principles of mathematics, by which the military arts are to be understood.[104] Mathematics is brought forth from light;

[102] Guarino Guarini, *Trattato di Fortificatione* (Turin: Heredi di Carlo Gianelli, 1676), 2. "*Quest'Operetta mia di Fortificatione povera, e dimessa, esce alla luce…*"

[103] Euclidis, *Optica et Catoptrica* (Paris: Ex Officina Dionysii Duvallii, via Belovaca, 1603), 1. "*Cum ea quæ ad aspectum attinent, demonstaret, iucundas aliquot rationes adferebat, quibus concluderet, omnem lucem secundum rectas lineas ferri: huiúsque rei maximum argumentum dabat, tum umbras è corporibus proiectas, tum radios per fenestras & rimas delatos: quorum nihil fieri videremus, ut nunc sit, nisi radii à sole misi in rectam lineam tenderent.*"

[104] Ibid., 5. "*Gl'Elementi di Euclide sono so necessarij ad ogni scienza matematica, che nó può profitare alcuno in esse, se in questa prima cognition elementare non è diligentemente versato; e per tanto qualonque vuole avanzarli nell'arte militare, deve credere, che questa sia la base, il principio, & il primo element, di cui si compone, e sopora a cui s'avanza, e cresce ogni sue speculatione*."; Guarini. *Euclides*, ("Benevolo Lectori"), unpaginated. "*Cum inter illos, qui in elementa Euclidis desudarunt, nullum intuear, unico concarcinare volumine, quæ ad quantitem sub genere investigandam faciunt, secutus seculi genium, quod centiuriat, ut plurimùm, & florilegia condit, putavi nequaquam me frugem perdere; si huic muneri universaliùs inservirem, & Mathematica rerum exordia ex omni parte rotunda, & contornata exiberem. Siquidem ex meo labore didici, euius pretij, cuius utilitatis id operis emergat ; quod ea omnia, quæ Mathematicas luces, & euidentias in unicum lucis fontem, adeoq, solem ne dum tumultuaria collectione aglomeret ; sed etiam ordinato agmine disponat, in seriesq ; suas naturali consecutione distinguat præcipué illis, qui nullo Mercurio tramitis indice, aut duce audent se huic studio consignare, & admodùm dificilem provinciam in suam sarcinam traducere.*" It is interesting that the mention of Mercury's transmission referenced here within the untranslated part of this quote might in fact pertain to the planet's transit over the sun in 1661. This celestial phenomenon was

geometry originates from mathematics; from geometry, architectural forms can be constructed. At the core of this progression is the idea that light is to be thought of as synonymous with architecture.

Guarini provides specific instructions on how to apply the principles of mathematics to build defensive fortifications for specific places in Turin and the region of Piedmont. He presents the first principle of constructing fortifications: "Each part of the fortress has the ability to defend the city not only by direct offense from the front, but also by parallel and oblique defense."[105] This, in light of the first section on Euclidean geometry, demonstrates the universal relationship between surface and angle of incidence, translated into military stratagem.

The fortification system at the end of the treatise is a progression of geometric diagrams that culminate in a design for a pentagonal stronghold, closely resembling the citadel of Turin, built in 1564 by Francesco Paciotto (1521–1591). Guarini's role in serving Prince Ludovico as an instructor in the military arts was brought about by a concern for the safety of Turin from foreign attack. The pentagonal fortification illustrated by Guarini may have ultimately been implemented as a new phase in the ongoing construction of the citadel.[106]

The progression of Euclidean forms in the creation of Guarini's fortification design connects light to structure, divine potentiality to corporeality, in a manner that is discussed

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also observed by the astronomer and contemporary of Guarini, Christiaan Huygens. This celestial phenomenon would have also allowed for certain astronomical observations exemplified in Guarini's *Cælestis*. This reference may also be observed in note 77: Ibid., ("Benevolo Lectori"), in which "Mercury transmits no indexical path…"

[105] Ibid., 37. "*Principio I: Ogni parte della fortezza dove potersi diffendere da cittadini non solo con offesa diretta, e per fronte, ma anche con difessa paraella, & obliqua.*"

[106] Guarini, *Fortificatione*, 1.

in great length in the *Placita*.[107] Guarini's method of connecting the metaphysics of light to the construction of fortification systems is bellicose; the abutments of the citadel become defenses like the bastions and apotropaic guardians of the Gothic cathedral.

Amidst the unfulfilled commission for San Gaetano and the writing of the *Trattato*, Guarini was assigned to take over a project for a chapel being built behind the Turin Cathedral of San Giovanni Battista (1491–1498). The desire of the Savoy family in building it was to create a reliquary and worship space for the *Sindone*, a most coveted relic believed to be the burial shroud of Christ. The legend of the *Sindone* comes from the mid-fourteenth century, when one of the knights of Philippe VI first bestowed the shroud unto the canons of Lirey. The shroud was previously kept at San Chapelle in Chambéry, France (1408–1502) by the Savoy dynasty.[108]

Saint Charles Borromeo (1538–1584) venerated the shroud during his tenure as the Archbishop of Milan during the sixteenth century, making a number of pilgrimages and holding ostentions at which the relic was on view.[109] Borromeo's desire was to create a permanent reliquary for the shroud within Turin Cathedral. However, the decision was made by Carlo Emanuele I to create a separate chapel for the relic that would be connected to the cathedral by two sets of stairs with vestibules that lead into the worship space. The chapel would become the *Theatrum Sabaudiae*, intended to expose and glorify the Shroud of Turin as the most holy cloth of one of the most powerful dynasties in Europe.[110]

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[107] Guarini, *Placita*, 109. "*Verù & in hac convenit cum luce, quæ non habet aliquod contrarium, & forte cum multis aliis accidentibus: quare cùm nulla proprietas substantiæ generet notionem propriam substantiæ, quæ eam distinguat ab accidentibus; remanet solùm, vel fumere omnes proprietates per modum unius, ita ut per hanc proprietatum congeriem ab omnibus differens agnoscatur, eò quia quæ substantia non sunt, semper aliquâ ex iis careant: vel sequentem conclusionem recipere.*"
[108] John Beldon Scott, *Architecture for the Shroud: Relic and Ritual in Turin* (Chicago and London: The University of Chicago Press, 2003), 3, 39.
[109] Ibid., 69.
[110] Dardanello, "Dall'ovale alla Rotonda," 305.

12.
Chapel of the Holy Shroud, View down the stairs toward the Cathedral
Photography by author, 2018

Asciano Vitozzi was commissioned for the project and continued work on it until the 1620s.[111] With not much more than the foundations laid by Vitozzi, Prince Maurizio ordered that a new plan be drawn up by Carlo's son, Amedeo di Castellamonte. The architect and sculptor Bernardino Quadri (1625–1695) was also asked to develop another design to be put next to the designs of Carlo and Amedeo for consideration. Quadri's design was swiftly accepted and construction was underway by the winter of 1657.[112]

13.
Antonio Bertola, Reliquary, Chapel of the Holy Shroud (interior), Turin

Quadri worked on the project into the late 1650s, completing the masonry shell of the rotunda up to the level of the cornice as well as many of the columns and pilasters.[113]

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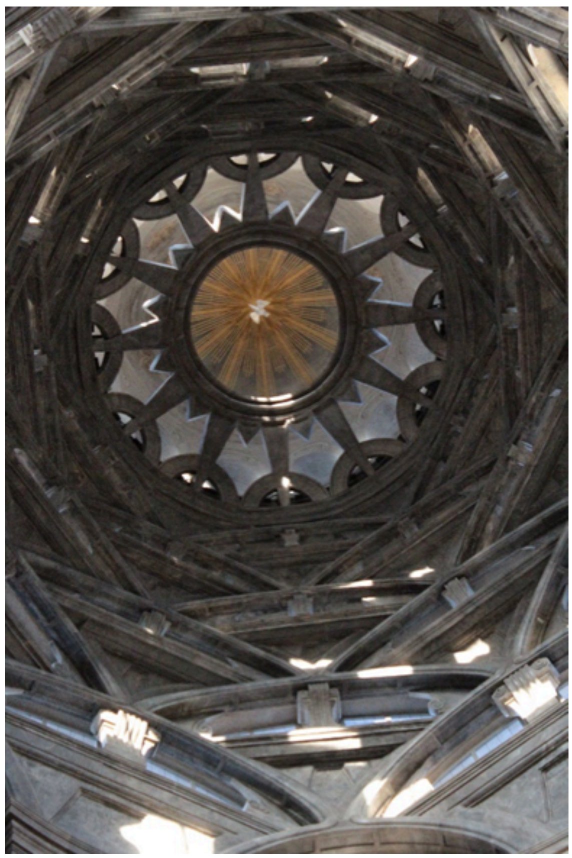
[111] Ibid., 90.
[112] Meek, *Guarini*, 64.; Dardanello, "Dall'ovale alla Rotonda," 294–97.
[113] Paolo Napoli, "A Structural Description of the Chapel of the Holy Shroud in Turin," *Nexus Network Journal* 11 (2009): 351–68.

However, Quadri ran across structural and scenographic problems in designing a visually impressive dome after completing the rotunda, and how to effectively illuminate the reliquary that would hold the shroud.[114]

14.
Detail of the Chapel of the Holy Shroud showing the cornice of the rotonda
Photograph by author, 2018

[114] Dardanello, "Dall'ovale alla Rotonda," 301.

Guarini was confronted by the Prince to propose a solution to the two problems that Quadri faced. He met this kind of challenge with great success in his early work for Castagnini on San Vincenzo and after proposing a remarkable solution, was handed the project for the chapel in 1667. Surely, it was this solution that compelled Carlo Emanuele II to nominate Guarini for the role of court engineer.[115]



15.
Cupola, Chapel of the Holy Shroud, Turin
The Royal Church of San Lorenzo
Photography by author, 2018

[115] Augusto Cavallari Murat, *Forma Urbana ed Architettura nella Torino Barocca*, *Tomo Secondo* (Torino: Unione Tipografico – Editrice Torinese, 1968), 1063.; Giuseppe Dardanello, "Dall'ovale alla rotunda. I presupposti del progetto di Guarini per la cappella della Sindone" in *Guarino Guarini*, ed. Giuseppe Dardanello, Susan Klaiber and Henry A. Millon (Turin: Umberto Allemandi & C., 2006), 291.

Emanuele Filiberto (1528–1580), the great-grandfather of Carlo Emanuele II, vowed to construct a church in memory of San Lorenzo if victorious over the French at the battle of San Quentin, which took place on the feast day of San Lorenzo, the tenth of August, 1557.[116] Remaining true to Roman tradition, Filiberto chose a site for the church where another structure once stood, because of the centrality of the location to the Piazza Castello and its vicinity to Turin Cathedral and the Palazzo Vecchio.

There are five hundred years of archival and archaeological records which pertain to the site, including the evidence of a medieval church known as *Ecclesiam Beatae Mariae ad Presepem*, otherwise known as the church of Santa Maria del Presepe that dates to 1177.[117] Santa Maria was a late Romanesque period church, built in the Lombardian style with blind archways along the exterior, a long central nave that led to a hemispherical apse, two side altars and an ambulatory of groin vaults, which were at one time richly decorated with frescoes.[118]

Filiberto first offered Asciano Vitozzi (1539–1615) and Carlo Castellamonte (1560–1641) the commission in 1563 to build the Church of San Lorenzo on the site of Santa Maria del Presepe. Using the footprint of the old church, two side chapels were extended on either side of the nave, creating a cruciform structure. Vitozzi and Castellamonte

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[116] Susan Klaiber, "I disegni di Guarini per le cupole" in *Guarini, Juvarra e Antonelli: Segni e simboli per Torino*, ed. Giuseppe Dardanello and Rosa Tamborrino (Milano, Italia: Silvana Editoriale Spa, 2008), 119. "*La chiesa di San Lorenzo commemora la vittoria delle truppe di Filippo II di Spagna guidate da Emanuele Filiberto di Savoia nella battaglia di San Quintino in Piccardia, il 10 agosto 1557, festa di San Lorenzo; vittoria chef u di stimolo per la costruzione dell'Escorial di Filippo II.*"; Luciano Tamburini, *Le Chiese di Torino dal Rinascimento al Barocco* (Torino, Italia: Le Bouquiniste, 1968), 201.

[117] Reference to Crepaldi's research is quoted in Robison, "San Lorenzo," 67; The original source of this research can be found in Giuseppe Michele Crepaldi, *La Real Chiesa di San Lorenzo* (Torino: Dagnino, 1963), 11.

[118] Robison, "San Lorenzo," 67.

redesigned the vaulting and added windows allowing for the penetration of sunlight into the previously dark and narrow medieval space.

Filiberto's son, Carlo Emanuele I, who ruled as Duke of Savoy from 1562 to 1630, was influential in forming a chapter for the Theatine Order along with the apostolic ambassador Padre Tolosa. The financial patronage of the Duke allowed the Theatines to acquire the land next to the Church of Santissima Trinità as a site for their chapter house.[119] After the Duke's death in 1630, the tumultuous political and financial situation in Turin began to stabilize. Taking this new situation into account, Carlo Emanuele's son Vittorio Amedeo I (1587–1637) granted the Theatines the rights to the Church of San Lorenzo in 1666.[120]

Further renovations were undertaken by the Theatines and the next phase of the project was passed on to Carlo di Castellamonte's son, Amadeo (1610–1683) and to Guarini, who had recently arrived from Paris. The evolution of the site from the medieval church of Santa Maria del Presepe to the Church of San Lorenzo, as it exists now, is not entirely clear. In July of 1668, Vittorio Amedeo's son, Carlo Emanuele II, hired Guarini as

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[119] Ibid., 79.

[120] Ibid., 81. Crepaldi is quoted in Robison's dissertation as stating that, "It would not be impossible to erect a new and grandiose church."; Umberto Chierici "Guarini a Torino" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino, Italy: Accademia delle Scienze, 1970), 360. Chierici points to an interruption during the process of renovation from 1634 until the bestowal of the church to the Theatines in 1666.; Susan Elizabeth Klaiber, "Guarino Guarini's Theatine Architecture" (Ph.D. Diss., Columbia University, 1993), 6. Klaiber points to the Savoy family as the Theatine Order's most powerful patron, financing a great deal of their architectural and ecclesiological endeavors around Europe. It is through this powerful dynasty that Guarini received his most important commissions including San Lorenzo, as well as the Palazzo Carignano (1679), St. Anne la Royale in Paris (1662) and Santa Maria della Misericordia (c. 1679–1681) in Lisbon.

court mathematician and engineer and handed over the project of San Lorenzo to him at that time.[121]

Guarini's design for a centrally-planned church may have been influenced by designs first brought north from central Italy to Turin by Vitozzi in the late sixteenth century, including the Capuchin church of 1583, and Santa Trinità of 1590. Vitozzi was influenced by the Renaissance architects Filippo Brunelleschi (1377–1446), Leon Battista Alberti (1404–1472), and Donato Bramante (1444–1514).[122] It is possible that Vitozzi's original plan for the site of Santa Maria del Presepe was for a centrally-planned building and that Guarini took it upon himself to undertake and to reinterpret what Vitozzi had originally intended.

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[121] Chierici, "Torino," 359.; Quoted in, Robison, *San Lorenzo*, 82. The original document is quoted in, Crepaldi, *La Real Chiesa*, 38. The original document is, Archivio Regia Camera dei Conti, *Patenti*, rig. LIII, 50. The original archival document found in Crepaldi's book reads, "*Et essendosi ritrovata una casa con sito molto più capace dell'antidetta a posta a Piazza Castello et vicino al palazzo et corte del medemo Sig. Principe Cardinale, et Nostro luogo proprio, et conveniente per erigervi una chiesa, sebbene del tutto ruinato, non di meno, ponno essi Padri accomidarvisi di Convento, et farvi detta Congregatione. Abbiamo stimato molto a proposito prendere detto sito, et fargliene, persuasi che non gli Mancherà per mezzo Nostro, et delle limosine, che gli verran fatte, di poter fa la fabbrica necessaria per detto Convento, chiesa et Congregatione.*" My translation differs somewhat from Robison's, and my choice to give a more formal inflection to the phrases stems from the use of seventeenth-century Italian in the original manuscript. Robison's translation reads as such, "having found a building with a site much more ample than the beforementioned, sited at Piazza Castello and near the palace and Court of the aforesaid Sig. Prince Cardinal and Our palace, and advantageous for the erection of a church, although all ruined [the site], nonetheless, the Fathers can accommodate themselves in a Convent there, and make said Congregation there. We have esteemed it highly appropriate to take the said site and give it to them, persuaded that they will not lack through Our means and through alms that will be given to them, enough to enable them to construct the building necessary for said Convent, church and Congregation."

[122] Meek, *Guarino Guarini*, 45.; Carboneri, "Introduzione," xiii. "*A Torino il Guarini giungeva forte di un'esperienza complessa, arricchita da elementi romani, emiliani e siciliani, posti a confront con la cultura e con la tradizione architettonica francese (e forse anche iberica, se si accetta l'ipotesi, però non documentata, di un suo viaggio durante il soggiorno parigino), la quale d'altra parte era venuta in contatto con il Bernini e con altri artisti italiane per la fabbrica del Louvre.*"

16.
View of San Lorenzo from the Piazza Reale toward the Royal Palace of Turin
Photograph by author, 2018

Several documents also point to the construction of San Lorenzo beginning in January of 1670, including the *Libro della Fabbrica* (a construction record). There are also a number of documents referring to the demolition of the cruciform church constructed by Vitozzi and which was continued by Carlo and Amedeo Castellamonte. Within this evolution of building, it is clear that upon Guarini's arrival in Turin and involvement with the Savoy Dynasty, he immediately became an architect in high demand.

There are many aspects of Guarini's design for San Lorenzo that claim its significance as a masterful and culminating work. This is proven in the sophistication seen in the plan and design for the church. However, due to the theoretically and mathematically complex nature of San Lorenzo, this does not really come clear without the full realization of the architect's mind within his late masterpieces of architecture and literature.

17.
Church of San Lorenzo up to the dome and the lantern from the Piazza Reale
Photography by author, 2018

Late Work

Guarini's late work after San Lorenzo is the most significant and productive of his entire literary *œuvre*. After working as a mathematician and engineer for the court, he was appointed to the University of Turin, where he worked alongside another giant of the world of seventeenth-century mathematics, Claude François Milliet Dechales (1611–1678).

As a professor at the University of Turin, Guarini would publish three new treatises prior to his death, the *Euclides adauctus*, the *Modo di Misurare le Fabbriche* and the *Trattato di Fortificazione*. Guarini would publish three other treatises which would be published posthumously, those being the *Leges Temporum et Planetarum*, the *Compendio della sfera celeste*, the *Cælestis Mathematicae* and the *Architettura Civile*.

In the midst of his multitude of literary projects, Guarini would undertake several new commissions concerning architectural design, including the Castello di Raconiggi (1677), the Santuaria della Consolata (1678) and the Palazzo Carignano (1679). He is also credited with the church of Santa Maria da Altötting in Prague (1679) and the Santuario d' Oropa in Biella, Italy in 1680.[123] Given the status of his work as a professor at the University of Turin, he most likely advised many of these projects with which he is credited as an accomplished late-career architect and theorist.

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[123] Carboneri, "Introduzione," xxxix.; Klaiber, "Guarino Guarini, il mondo di un architetto religioso del Seicento," in *Guarini, Juvarra e Antonelli: Segni e simboli per Torino*, ed. Giuseppe Dardanello and Rosa Tamborrino (Milano, Italia: Silvana Editoriale, 2008), 67–8.; Ibid., 71.; Amelio Fara, "Geometrie della fortificazione e architettura da Borromini a Guarini" in *Mitteilungen des Kunsthistorischen Institutes in Florenz* 45, ½ (2001): 133.; Sandonnini, *Lives of the Celebrated Architects*, 240.; Meek, *Guarino Guarini*, 127.

The work of Guarini's late career, both architectural and literary, exhibits an emphasis on what seems to be demonstrated in the Church of San Lorenzo as a culminating work. In the manner that the *disegnatore* works tirelessly for a plan for a building, producing sketches and studies, most abstract and intricate to arrive at a finished design, Guarini's prior accomplishments can be seen as fragments which San Lorenzo embodies as a whole.

The *Euclides Adauctus*, which was released three years after the commission of San Lorenzo, is a mathematical reflection of its culmination as an architectural work. It embodies an advancement of Euclidean science by transforming the substance of light into form through the elegance of the moving universe.

The preface of the *Euclides* (*Benevolo Lectori*) begins, like most of Guarini's treatises, by stating the unequivocal importance of light. All that exists is mathematical and of this light, brought into being from a great and luminous font (*quod ea omnia, quae mathematicas luces, & evidentias in unicum lucis fontem*). From this font, light surrounds the geometrical form of the sphere (*mathematica rerum exordia ex omni parte rotunda, & contornata exiberem*). Guarini references his previous publication, the *Placita*, stating that this work brought him over the threshold of knowledge (*à limine incespitavit*) while shortly thereafter in 1667 his colleague, the Theatine philosopher Ioannes Bonifacius Bagatta (Giovanni Bonifacio Bagatta, 1649–1702), published the Cursus Philosophicus.

Bagatta's publication includes an extensive analysis of Aristotelian syllogistics, including a commentary on Guarini's ideas concerning the Categories (*praedicamenta*), a form of grammatical predication which Guarini uses as a form of logic, demonstrating the structural relationship and delineation between physical species.

Bagatta elucidates Guarini's idea that all matter is of the same substance, whose categories (*praedicamenta*) change according to their occurrence (*accidens*). Applying the Aristotelian Categories to architecture, form, geometry and light may be thought of as different modifications or physical species of the same essential substance. Light is the generative element; its spatial extension is delineated by geometry; in turn, Guarini as mathematician and architect calculates these dimensions and, therefore, applies them to the art of building.

Guarini's theory on the *praedicamenta* refutes Bagatta at a critical point, defending the pure potentiality of form (*forma esse pura potentiam*) and pointing to the creation of matter from nothing. He denounces Bagatta's position based on Genesis (*terra autem inanis et vacua et tenebrae*, Gen. 1:2), claiming that his theory is scripturally extemporaneous and may therefore, be deceptive to his reader without being clear on his theological view (*vel quod scriptorum meorum, quos extemporaneos, & subletos eccepit alique fortè positione delusus*).

The relevance of Guarini's diatribe against Bagatta in the preface to the *Euclides* evinces the fundamental importance of light in the creation of form and substance, geometry and architecture. Light is form, the substance of creation. God creates light (*fiat lux, et facta est lux*) and the light creates form by dividing it from the darkness (*divisit lucem ac tenebras*, Gen., 1:3–4). The refutation is also a necessary adherence to orthodoxy (*orthodoxae religioni*) that is confirmed by the eight members of the clergy that state their approval in the Imprimatur.

In 1674, Guarini published his architectural treatise *Modo di misurare le fabbriche* (Methods of measurement for construction). The treatise is dedicated to the painter Giovanni Andrea Ferrari, who was Count of Bagnolo and the minister of finance for the engineer, military architect and Duke of Savoy, Amedeo di Castellamonte. Ferrari was a prolific painter and draftsman, largely active in the region of Genoa.[124] Guarini states that the purpose of the treatise is to allow Ferrari to more aptly serve as finance minister for the House of Savoy.

As in the *Civile*, the *Placita* and the *Compendio*, the *Modo di Misurare* connects the measurement of buildings to the movement of the celestial sphere. Addressing Ferrari, Guarini states that the royal house is to be constructed as a machine that is meant to be perfectly aligned to the movement of the celestial sphere (*tanto bene moderna questa machina, che non vi e movimento di sfera sì perfettamente agguistato*).[125] The building of San Lorenzo as a sundial connects the church to light and to time. Light is the radiance of the sun and time is measured according to its movement. This dissertation builds upon Fagiolo's theory of the *geosofia*, but from the vantage point of the sun at the center of Guarini's cosmology.[126]

The *Compendio della Sfera Celeste*, published in Turin by Giorgio Colonna in 1675 is dedicated to Giovanni Battista Truchi, advisor of the state, first president and head of the council of finance of the Duke of Savoy. The dedication is not intended as merely a sign

[124] Mary Newcome, "Ludovico Caracci, Jacopo da Empoli, Giovanni Andrea de Ferrari: Notes on Three Drawings in the Palazzo Rosso in Genoa" in *Master Drawings* 23/24, 2 (1985/1986): 205.
[125] Guarino Guarini, *Modo di Misurare le Fabbriche* (Turin: Per gl'Heredi Gianelli, 1674), 3–4.
[126] Francesca Filippi, "La struttura nascosta della chiesa di San Lorenzo," in *Guarini, Juvarra e Antonelli: Segni e simboli per Torino*, e. Giuseppe Dardanello and Rosa Tamborrino (Milano: Silvana Editoriale, 2008), 122.

of partnership but as an honorable recognition of Truchi's work as the head of finance for the duke, who had recently passed away that year.[127]

The dedication to Truchi in the *Compendio* holds true to the dedications of his other treatises in which he connects the cosmological theme of the treatise to the personal or political desires of the patron. Guarini states that the chapters of his short treatise (*questo breve compendio*) contain the knowledge to predict an eclipse as well as the knowledge of the *primum mobile* and the horology of the sun, presenting Truchi the light of this knowledge for his years of financial patronage. The *Compendio* is a brief preamble to what follows, alluding to the *Caelestis Mathematicae*, which would be published twelve years later.[128]

La Sfera Artificiale, e Naturale, written by Ludovico Passerone, was published in Turin shortly after Guarini's *Compendio* by Bartolomeo Zapatta. Passerone's dedication is addressed to the Prince of Piedmont, Vittorio Amedeo di Savoia, dated March of 1675. The *Imprimatur* of Passerone's treatise is written by Bartolomeo Torrini and is followed by a *Nihil Obstat* written by Guarini, under the order of Michele Ludovico Theunardi, Inquisitor General of Turin. Theunardi was also commissioned by Lorenzo Maccialdi to write the *Imprimatur* for Guarini's *Compendio* as well, which appears at the end of the document. Guarini states that everything in Passerone's treatise is free of any repugnance to the faith (theological error), that it is written clearly and that the power of its knowledge places it in the light of God.[129]

[127] Lange, "Disegni," 218.
[128] Ibid.
[129] Ludovico Passerone, *La Sfera Artificiale, e Naturale* (Turin: Bartolomeo Zapatta, 1675), (unpaginated). "*D' Ordini del Reverendiss. Padre Michele Ludovico Theunardi di Inquisitor Generale di Torino; Io D. Guarino Guarini di Chierici Regolari Thelogo, e Matematico hò revista* La Sfera Artificiale, e Naturale *del*

Much like Guarini's dedication to Torres in the *Placita Philosophica* and Ferrari in the *Modo di Misurare*, the commemoration of the *Compendio* to Truchi discusses the celestial sphere not only in light of astronomy, but in terms of politics and power. Guarini expresses that while the effect of his book may be small, its subject matter is of vast proportion and may serve to amplify the power of the duke (*Effeto è il libro delle mie deboli forze, la materia di lui è una vastità proportionata all' ampie sue prerogative*).[130]

Guarini states that the sphere (*così questa mia sfera*) will be like nothing else that has ever affected the greatness of his intellect (*sarà come niente capita dal suo gran intelleto*), effectively putting the duke at the center of command (*al centro di suoi ambiti commandi*).[131] Guarini also emphasizes that the heavens are at the duke's disposal; that they have no other locus than him at the center (*questo nostro cielo non hà altro loco*), appealing not merely to the fervent desire to rule, but also alluding to the egocentric adherence to the theory of geocentrism that came along with it in the seventeenth century.[132]

Passerone's dedication to Vittorio Amedeo in his treatise on *La Sfera* is similar in nature to Guarini's, expressing that this "material sphere" will bestow the prince and his line of royalty a universal power (*che doveva haver dell' Universo*) as a tool for rulership, power and conquest (*possesso del suoi vastissimi Regni animarlo à maggiori conquiste*).[133]

Sig. Ludovico Passerone di Lantosca Dottore d'ambe le Leggi, e non havendo in essa conosciuta cosa, che repugni alla Fede, buoni costumi; anzi per ogni parte molto chiara, e facile, stimo si possa porre alla luce. D. Guarino Guarini C.R."; Lange, "Disegni," 219. "*Purtroppo questo amico generoso e interessato nell'argomento, e dotato di mezzi rimane nell'ombra. Forse per l'interesse nell'astrologia (come era chiamata allora l'astronomia), e nella matematica, nel giudizio dell'utilità del libro anche ad altri (come potrebb'essere di un libro utile a studenti), l'ombra dell'accenno potrebbe diradarsi fino a lasciare intravedere la persona del medico di Corte, matematico e astrologo, Bartolomeo Torrini, il censore entusiasta dell'* Euclides adauctus *di cui si è parlato sopra.*"

130 Guarino Guarini, *Compendio della Sfera Celeste* (Turin: Giorgio Colonna, 1675), (unpaginated).

131 Ibid., (unpaginated).

132 Ibid., (unpaginated).

133 Passerone, *La Sfera*, (unpaginated).

It is perhaps an oversimplification, however, to only think of these royal introductions as an appeal to power. Guarini's *Compendio* as well as Passerone's *La Sfera* would have been seen as very theoretical. However, *La Sfera* is also practical, didactic and pragmatic to a ruling class during the seventeenth century in a broadly expanding Age of Exploration. Expanding on many of Guarini's ideas, Passerone connects the horology of the sun to mechanics which can be used for civil, nautical or military engineering.[134] The facility of power is that of navigation, which is made possible by determining terrestrial coordinates according to the movement of the sun and the stars and one's relative position upon the surface of the earth.

Guarini presents his hypothesis in the prologue, which is to explain the movement of the heavens and to predict eclipses by way of the *primum mobile* and the horology of the sun, according to astronomical tables (*hipotesi spiego i movimenti celesti e già composte le tavole di secondi mobili* [*sic*] *à predir l'eclisse, parte a primi mobili, & alli horologgi da sole*).[135] He states that his intention with the *Compendio* is to present the reader with a clear, fundamental knowledge of the science of the celestial sphere, for those who cannot be afforded the time to read such a large volume or to indulge their thoughts in greater speculation (*non havendo tempo di leggere un gran volume, ò non si dilettando di profonde speculatione*).[136]

Guarini's hypothesis in the *Compendio* is connected to his architecture theory. The understanding of the movement of heavenly bodies around the celestial sphere relates to

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[134] Ibid., 11.
[135] Ibid., 1.; Aristotle, *Metaphysics*, trans. Richard Hope (New York: Columbia University Press, 1960), 360. The *primum mobile* is a concept presented in the *Metaphysics* as "*οθεν η αρχη τηςμ κινσεως* (*unde principium motus*), that whereby the movement is started."
[136] Ibid.

the knowledge of gnomonics, the connection of architecture to the movement of the passing sun. If the shadow cast by the gnomon of the sundial is instead a fenestration within the dome of a church such as San Lorenzo, then the shadow is instead a shaft of light—a corpuscular beam moving around the interior of the dome, demarcating time and the seasons within the movement of the sun in the heavens.

In Chapter One of the *Compendio*, Guarini describes the sphericity of the heavens (*Della rotondità del Cielo*), fortifying his claim by referencing a number of ancient and early modern astronomers, including Geminus of Rhodes (fl. 1 c. BC), Cleomenes (1st c. BC), Meton of Athens (5th c. BC), Martianus Capella (fl. c. 410–420), Proclus Lycaeus (412–485), Johannes Stöffler (1452–1531), Erasmus Reinhold (1511–1553), Johannes de Sacrobosco (1195–1256), Prosdocimus de Belemandis (Prodoximus, d. 1428) and Christopher Clavius (1538–1612).[137] Guarini eloquently describes the celestial sphere as a pathway of the planets and stars, serving to direct their fundamental course around the sun and its boundaries.[138]

Chapter Two of the *Compendio* begins by describing the parts of the celestial sphere, in general (*Delle Sfera, e sue parte in generale*), while the subsequent chapter describes these constituents at an increasingly greater level of intricacy.[139] Guarini discusses the celestial pole as an axis point, stating that each of the rings which the planets and stars follow along the equator, meridian, ecliptic, tropic or from orient to occident, also have an

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[137] Guarini, *Compendio*, 1–2. "*Che il cielo si a rotondo, tutti li autori che scrissero della Sfera del applauso commune lo confessarono. Gemini nelli elementi Astron. Cleomene, Metala, Martiano, Proclo, Giovanni Stoeflero, Erasmo, Prodoximo, Clavio, & altri, e con ragione.*" Guarini was most likely referring to *De Motu Circulari* by Cleomenes, and to the *De nuptiis Philologiae et Mercurii*, by Martianus Capella.
[138] Ibid., 2. "*Quindi è, che per rappresentare la rotondità del Cielo, & i viaggi circolari di Pianeti gl' astronomi saggiamente habitanno inventato la Sfera, la quale non è altro, che un' intreccio materiale di diversi circoli i quali servono per rappresentare i corsi principalmente del Sole, & i suoi varij confini.…*"
[139] Ibid., 2.

axis point of their own. The knowledge of each element containing its own axis is explained by Euclid as well (*del nostro Euclide accresciuto, spiegata la sfera*), who assigns each ring of the celestial sphere with its own set of properties through mathematical demonstration.[140] The celestial pole is the axis which determines the measurement of the sun's movement throughout the year; the position of the sun determines the shadow cast by the gnomon upon the face of the sundial, or the direction of light entering the interior of the church.[141]

Each successive chapter of the *Compendio* describes the parts of the celestial sphere in increasingly greater detail. The celestial sphere that Guarini describes in Book Two of the *Civile* is a more succinct, simplified version; the purpose of the *Circoli della Sfera Celeste* is didactic, intended to properly locate the site for a building and its alignment with the *angoli del mondo*.[142] The *Compendio* is a brief preamble to what follows, alluding to the *Caelestis Mathematicae*, which would be published twelve years later.[143]

The movement of the sun throughout the year is described in Chapter Six on the Ecliptic and the Zodiac (*Della Ecclitica, e Zodiaco*): The year is, therefore, the measurement of the movement of the sun along the ecliptic from the vantage point of the earth

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[140] Ibid., 2–3. "*Habbiamo nell' Trattato 23 del nostro Euclide accresciuto, spiegata la Sfera*…"; Guarini's reference to Euclid is from the *Phaenomena* (*φαινομενων*), an astronomical work pertaining to spherical geometry. See Euclid, *The Thirteen Books of Euclid's Elements, vol. 1*, ed. Thomas L. Heath (New York: Dover Publications, 1956), 17.; J.L. Heiberg, *Studien Über Euklid* (Leipzig: Druck und Verlag von B.G. Teubner, 1882), 50, 165.

[141] Ibid., 5. "*I circolo principali della Sfera sono dici, cioè l'Equatore, il Zodiaco, i due Coluri, l'Orizonte, il Meridiano, i due Tropici, e i due Polari, e quest, i altri sono, per cui camina il Sole, altri servono per termine, e per confine de suoi viaggi. Ponendo dunque il Sole la dove fa il giorno eguale alle notte, per esempio in H, nel quale punto fra lontano, egualméte da i polo sarà aggirandosi attorno al circolo massimo GHFZ, perche si terrà almen sensibilmente in quel giorno col suo camino in egual distanza da i poli D, & E, ma perche à poco, à poco nella successione de giorni s' accosta maggiormente, hora à questo Polo, hora a quell' altro, quindi è, che e quando al giunge all' ultima vicinanza, dopo cui comincia à ritornar in dietro…*"; Euclid, *Euclid's Elements of Geometry*, trans. E. Stone (London: John Rivington, William Johnston and Thomas Longman, 1765), 313.

[142] Guarini, *Civile*, 48.

[143] Guarini, *Compendio*, (unpaginated).

(*L'anno dunque, e misurato dal moto, che fa il Sole attorno il Módo per l'Ecclitica*).[144] Guarini describes the difference between the 'artificial' and the 'natural' sphere that Passerone also discusses in his treatise, stating that the natural order of time contains twenty-four hours, and both day and night. The artificial sphere is that in which we observe the sun passing above the earth, described by the hemisphere of the celestial dome (*il sole sopra alla terra, & illustra il nostro Emisfero*).[145]

Guarini died on the sixth of March, 1683. He had still been at work on La Santissima Sindone and the Palazzo Ducale and awaiting the release of his two-volume treatise on celestial mathematics, *Cælestis Mathematicae pars prima et secunda*. Both volumes were published posthumously in the same year and two other previously published works developed out of it, including the *Compendio della sfera celeste* (Compendium of the celestial sphere) and a treatise concerning time and the movement of the planets according to the Aristotelian *primum mobile*, entitled *Leges temporum et planetarum* (The Laws of Time and the Planets).[146]

Part One of the *Caelestis* describes the celestial sphere and the movement of the planets within its intricate design. Part Two provides a brief history and theory of gnomonics, from the horology of the sun, to the concentric delineations of measurement on the base of the sundial, a description of gnomonics in ancient Rome and Babylonia and gnomonics as they pertain to the signs and positions of the Zodiac.

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[144] Ibid., 35.
[145] Ibid.
[146] *Caelestis Mathematicae, Pars Prima et Secunda*, was published the year of Guarini's death in 1683 by the Milanese press, Ludovici Montiae. *Pars Prima* is dedicated to Francisco II d'Este, Duke of Modena from 1662 to 1694. *Pars Secunda* is dedicated to Emanuele Filiberto, Duke of Savoy from 1553–80.
Ibid., xvii.; Robison, "San Lorenzo," 35.; Guarino Guarini, *Leges Temporum, et Planetarum* (Augustæ Taurinorum [Turin]: Ex Typographia Hæredum Caroli Ianelli), 1678.

The introduction begins by welcoming Francisco II d'Este, the noble and generous Duke of Modena to take a walk on the heavens (*caelum pedibus tuis sisto magnanime Dux*), turning as if on an axis like a crown around the constellations (*te velut polum coronant ambitiosae constellationes*). Guarini continues on to say that "[a]ccordingly, if the duke looking upward, admires the glorious heavens, I beg he not turn away from the emanation of the stars, but that they bestow upon him contemplation" (*siquidem si gloriosas animi tui dotes admirabundus suspicio, radio non ab astris emendicare, sed elargiri contemplor*).[147]

The *Caelestis*, as well as a number of Guarini's other treatises, places the patron of the treatise within the seat of power in the celestial sphere. This relationship between astronomy and politics exists in a specific manner in the seventeenth century in the still burgeoning age of exploration. Gnomonics and the celestial sphere involve the development of cartography based on the position of the sun and the stars, as did the development of the astrolabe in the Arabic world. The knowledge of these sciences brings forth terrestrial, as well as nautical discovery, which maintains a close accord with the power of the monarchy, the church, the military, and the political advancement and domination of the Savoy Dynasty and the Holy Roman Empire.

The *Cælestis* represents the culmination of Guarini's posthumous publications until the release of the *Architettura Civile* in 1737. The depth and breadth of Guarini's literary accomplishments since the building of San Lorenzo exemplify his role in history as a largely misunderstood architect, until these late literary works can be seen in connection to his architecture, and most importantly, the Church of San Lorenzo.

[147] Guarini, *Cælestis*, (unpaginated).

II

The Church of San Lorenzo

Introduction

Chapter Two, "The Church of San Lorenzo" is divided chronologically into the five books of the *Architettura Civile*: Principles of Architecture (*della architettura in generale, e suoi principi*), Ichnography (*dell'ichnografia*), Elevation (*della ortografia elevata*), Orthography (*della ortografia gettata*) and Geodesy (*della geodesia*). Each of the five books is also moved through in succession in a manner that describes each part of San Lorenzo, both in generality and specificity according to the *Civile*, which is Guarini's most pragmatic treatise on architecture.

The core principles of Guarini's theory of architecture are: *edificare* (the art of building), *orologia*, or *gnomonica* (the study of time and the creation of sundials), and *macchinaria* (the study of movement and equilibrium in physical bodies).[1] The manner in which the second principle is connected to the first and to the third is both practical and esoteric, foundational and cosmological.

[1] Guarini, *Civile*, 6. "*L'Architettura secondo i vari generi delle fabbriche così variamente distinguesi. Vitruvio al lib. I, cap. 3, la distinse prima in tre, cioè in Arte di edificare, in Arte di fare orologi, or Gnomonica, ed in Mecanica, o Macchinaria.*"

Guarini defends these principles by referencing the architecture treatise of his colleague at the University of Turin, Claude François Milliet Dechales (1611–1678), who asserts that architecture is based on ancient scientific principles and that the invention of the contemporary architect is to create a remnant of ancient buildings according the laws of symmetry.[2] This simulacrum is based on the design of a preexistent building, as well as the geometrical symmetry of nature, aligning architecture with history, and with the tangencies of cartography, geography, and with the universe itself.

Guarini's method of connecting these three principles is connected to his use of system of philosophy that first presents itself in the *Placita*. The study of gnomonics is important in terms of the cosmology of the San Lorenzo, but it is also applied throughout the *Civile* as a practical method for stone cutting in every aspect of building and design. Therefore, Guarini's architectural *praxis* is valuable for readers who have as much of an interest in building and construction technology as they do with architectural theory, mathematics and cosmology.

The 1968 version of *Architettura Civile*, edited by Tavassi la Greca, contains forty-five tables of geometric diagrams that correlate with the text, which were only previously part of the *Euclides* and the *Cælestis* as mathematical proofs that correlate with the text, which serve essentially as equations which are written out. These diagrams, along with the use of color photographs will allow the reader to see specifically where Guarini's architectural theory is applied in each facet of San Lorenzo's design. As Guarini states in the *Civile*,

[2] Guarini, *Civile* (Tavassi la Greca), 16.; Claudii Francisci Milliet Dechales, *Cursus seu mundus mathematicus, tomus primus* (Lugduni: Annisonios, Joan. Pousel & Claud. Rigaud, 1690), 27. Toward the end of his life, Dechales taught mathematics at the University of Turin. Guarini's *Euclides* is referenced in Dechales' mathematics treatise *Cursus seu mundus mathematicus*, in his proemia on the progress of mathesis and the history of illustrious mathematicians.

"[a]rchitecture adopts measurement and is therefore dependent on geometry as its most primary element."[3]

The connection between architecture in terms of stone and foundation and cosmology is a giant step which, according to Guarini, requires the intervention of mathematics, a discipline of which architecture is only the disciple. Mathematics by its very nature allows one to make these kinds of leaps, which are often defined as a lemma (*λημμα*) and may also be defined as an epigram (*ἐπίγραμμα*) or an inscription. In Euclidean geometry, this involves the comparative calculation of ratios and geometric angles or sides to form correlations through syllogistic logic.[4] Guarini's method of applying the first and third architectural principles of the *Civile* to the second involves syllogistic logic as well, using the principle of gnomomics as the fulcrum or axis point according to the movement of the sun.

Guarini defines the lemma (*Quid sit Lemma*) as a necessary form of mathematical demonstration for certain fundamental propositions which must be tested beyond institutional assumptions (*lemma itaque est demonstratio, seu constructio, quae necessariò ad demonstrandum aliam propositionem principalem, & ad rem spectantem praeter institutum assumitur*).[5] The lemma is a necessary constituent of measurement concerning the cosmology of a building such as San Lorenzo because of the inherent nature of measurement and the relativity of size and because of the leap between foundation and cosmology. It is also the declination of angle and the measurement of distance that is assumed through the

[3] Guarini, *Civile*, 10.
[4] Euclid, *Elements, vol. 2*, 242–3. "…proof of a lemma to the effect that, if two similar figures are also equal, any pair of corresponding sides are equal. To supply this lemma is one alternative; another is to prove, as a preliminary proposition, a much more general theorem, viz. that, if the duplicate ratios of two ratios are equal, the two ratios are themselves equal."
[5] Ibid.

use of an astrolabe or spherical astrolabe (celestial sphere), which the dome of San Lorenzo represents, both symbolically as well as functionally.

The main purpose, therefore, of the following chapter is to present the reader with a clear understanding of how Guarini created this connection between building and foundation to a complex, elegant understanding of the universe that is embodied in the design of San Lorenzo. The proofs of these geometries are the demonstrations of which architecture is merely the disciple. The foundational elements of the geometries serve as a lemma to greater architectonic complexities, their geodesic connection to the earth and to the celestial sphere.[6] As their operations are infinite, their complexities will be elaborated by drawing upon Guarini's other treatises on philosophy, mathematics and astronomy as tangential points within the theory.

[6] Euclid, *Elements, vol. 1*, 114.

Architectural Principles (*Architettura in generale, e suoi principi*)

There are twelve arts which serve the first two principles of architecture and building fabrication: stone cutting (*lapidaria*), statuary (*statuaria*), pottery and brick making (*la figulina*), the creation of lime mortar (*l'arte calcaria*), the plastic arts, and stucco ornamentation (*la platica*), the smithing of mechanical parts (*l'arte fabbrile*), metal fabrication (*metallica*), ironsmithing (*ferraria*), painting (*la pittura*), plumbing (*l'arte plombaria*), plaster (*l'arte dealbatoria*) and the quarrying of stone (*la pastinatoria*).[7]

These practical, material components of building then relate to six other arts which are at the service of architecture to assure that the work is done correctly involving design. Those are: practical arithmetic (*l'aritmetica pratica*), altimetry (*l'altimetria*), planimetry (*planimetria*), geodesy (*geodesia*), stereometry (*stereometria*) and the law of servitude (*la legge de servitutibus*).[8]

The physicality of architecture (*le fabbriche*) is related to civic function; it is the responsibility of the architect to create a building founded upon the Vitruvian triad of solidity, functionality and elegance (*haec autem ita fieri debant ut habeatur ratio firmitatis, utilitatis, venustatis*).[9] These three principles are essential in Guarini's theory of architecture as well as in the evolution of cartography and urbanism that was in progress in Turin at that time.

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[7] Guarini, *Civile*, 2–3.
[8] Ibid., 3.
[9] Ibid., 14.; Vitruvius, *De architectura libri decem* (Venice: Franciscum Franciscum Senensem, & Ioan. Crugher Germanum, 1567), ; Augusto Cavallari Murat, *Forma Urbana ed Architettura nella Torino Barocca* (Torino: Unione Tipografico – Editrice Torinese, 1968), 99. "*Ciò che ai cartografi barocchi urgeva dire nella scena urbana non poteva non essere racchiuso nelle formule estetiche classiche e classicistiche; era infatti incluso nella stessa triade vitruviana* 'commodus, firmitas, venustas.'"

The first twelve building elements, along with these six other elements of design, are applied to the five books of the *Architettura Civile*: Principles of Architecture, Ichnography, Elevation, Orthography and Geodesy. These five principles are design methods in which the physical structure of the building conjoins with methods of perspective (*scenographium*) that need to be thought of in relation to the previous six as theoretical methods of design, which are built with the previous twelve material elements.

Mathematical mensuration is based on geometry in three dimensions: latitude, longitude and immensity (*enim trinam dimensionem longitudinem, latitudinem, & profunditatem*). According to these three constituents (*que sunt dimensiones ens quantum constituents*), the mensuration of geometrical space adheres to the principles of the *axis mundi*. From these constituents the cone, the cylinder and the sphere are formed, as well as number, time and the intensity of light (*Agit de conis, cylindris, sphaeris. De numeris, de tempore, de luminis intensione*). There is a potentially infinite division of numbers as all mathematical figures inscribed within the circle are exceeded by the hyperbola and asymptote (*hyperbolem ad asymptotum accedere in infinitum*).

The *Euclides Adauctus* states that simple arithmetic pertains to the general integration of numbers (*Arithmetica Simplex, & Generalis integrorum numerorum*). The corresponding relationship between arithmetic and geometry, in which the inscription of geometric forms is equal in proportion, supersedes any numerical inequality (*iam aliam provinciam aggreditur, & proportionem inaequalitas praecipuè considerare, vel saltem iam ab aequalitate praescindere incipit*).[10]

[10] Guarini, *Euclides*, 92.

In principle, this correspondence is maintained through the compositional unification of numerical multitude (*numerus est ex unitatibus composita multitudo*). Guarini's unification of numbers is based on equivalents; number corresponds with measurement or value (*unde unitas omniu numerorum erit communis mensura, quâ omnes mensurari poterunt*), so that the sum of greater and lesser numbers is the division of their sum (*omnis verò pars assumit nomen ab eo numero, per quem multiplicata metitur maiorem, ut 6. dicitur tertia pars numeri 18. quia 6. mulciplicatus per 3. metitur numerum 18*).[11] These numbers correspond as equal, because their sum and their parts are equal and thus cancel each other.

Guarini differentiates between this form of corresponding arithmetic and numbers which are non-equivalents (*partes autem*; *cùm non metitur*). If the delineations of measurement vary from their quantitative value, then the numbers do not divide into nothing (*metitur*), thus generating architectural space. This strange arithmetical relationship in which numbers are unequal according to 'normal' arithmetical calculation, is essential to the generation of Euclidean geometrical space and, therefore, to architecture. The non-equivalent relationship of numbers creates the propagation of space, the expansion of the indivisible point (*punctum indivisibilia*).

This relationship is evident within many of the architectural drawings and treatises of the ancient past through the Baroque period including Guarini's *Civile*, in which he states that proportion is a correspondence between two quantities which are commensurate with another (*proporzione è una corrispondenza de due quantità nel commensurarsi l'una coll'altra*).[12] The two quantities are commensurate only because they can be measured against a third, creating a spatial dimension. Referencing the Milanese architect Carlo

[11] Ibid.
[12] Guarini, *Civile*, 25.

Cesaro Osio (b. 1612), Guarini states that the creation of architectural symmetry and proportion requires an understanding of space that exists between two quantities.[13]

Osio's treatise, also entitled *Architettura Civile* (1661), describes two arithmetical relationships involving proportion: one that is rational and another that is irrational (*ogni proportione primieramente è ò rationale, ò irrationale*).[14] According to Osio's theory of proportion, rational proportions are combined to create their numerical equivalent. However, there is dimensional space created through the juxtaposition of unequal numerical values (*proportione poi di disuguaglianza è quella, che passa trà due quantità disuguali trà loro, come per esempio trà il 20. & il 10., trà 1 ' 8 e il 40., ò pure trà la linea di sei palmi, e quella di due, e simili*).[15] This theory of proportion allows for the articulation of spatial dimension used in architecture (*la proportione superarticolare*), including more complex quadratic geometries such as the squaring of the circle, or as Osio refers to it, the proportion of the diameter of the square (*la proportione del diametro del quadrato*).[16]

As Guarini states, the calculation of two numbers in mutual and relational measurement exists in inequality (*ratio est duorum numerorum mutua in ratione mensuratis, & mensurati relatio*), which exists as itself, divided (*alium faltem per unitates, quae in ipso sunt, metitur*).[17] Guarini continues by stating the metaphysical importance of mathematics (*metaphysicas cognovisse*). However, Guarini's theory of quantification is architectural, in a most fundamental, structural and pragmatic manner. The brilliance of these two aspects

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[13] Ibid. "*Dovendo l'Architetto impiegarsi nelle simmetrie, e propozioni, è necessario, che delle medesime n' abbia qualche cognizione: di queste ne tratta Carlo Cesare Osio nelle sue precognizioni più necessarie nell'Architettura pag. 31., e presuppone senza la medesime non potere l'Architetto procedere giustamente nelle sue operazioni.*"

[14] Carlo Cesare Osio, *Architettura Civile: Demostrativamente Proportionata et Accresciuta di Nuove Regole* (Milano: Archiepiscopale, 1661), 31–2.

[15] Ibid., 32.

[16] Ibid.

[17] Guarini, *Euclides*, 94.

of mathematics expressed in tandem, demonstrates the purposiveness of theology and metaphysics within the practical framework of measurement (as in the *Modo de Misurare le Fabbriche*), the art of building (*edifizio*) and stonecutting (*stereometria*).

The concept of the core foundation (*subiectum*) pertains to the fondament of a building itself, which physically upholds its mass and its weight, lifted from ground up through potential, action, and virtue (*macchinaria*) and connected to the universe through number, time and movement (*orologia*, *gnomonica*). The concept of *subiectum* connects the metaphysics of the sun to building technology because it is also the term for the plate of the sundial, used throughout the *Civile* as a form of construction technology.

Guarini's theory of design is complicated in a similar manner that the *Placita* and his other philosophical works are thought of through Aristotelian syllogistics and complicated mathematics. The way that these elemental concepts are introduced appears almost inside-out, as if a work of architecture must be thought of first as a highly intricate inverse equation. It is perhaps this method of building that allowed him to design San Lorenzo to seemingly move like infinite clockwork. The intricacy of San Lorenzo's exterior is important to begin with before we move into the interior of the church.

The exterior of San Lorenzo resembles a kind of timepiece, like a pocket watch or astrolabe with the cover closed. The church is set within a larger complex on the side of the Palazzo Reale, so that the facade is uniform with many of the other buildings within that space. Only the dome lacks this uniformity as it rises above the roofline.

Guarini's theory of architecture is unique in how he approaches San Lorenzo as a method of calculating time, a method that is demonstrated in the design aesthetics of the church's exterior. The function of the other two principles is the creation of the idea and its execution in building. The architect serves as progenitor of the idea; the builder serves its creation in physical form.[18]

Guarini's inclusion of the study of time is a departure from the ancient knowledge found in Vitruvius' *De Architectura*, principles of science that were incorporated into such buildings as the Pantheon or the use of the obelisk as a sundial. The design of San Lorenzo incorporates most of the dome but does not really look hemispherical, but rather like a complex interaction of baroque entablature.

Each side of the dome from the exterior is vertical and concave with large windows that appear elliptical when seen in connection to the entablature that surrounds them. The effect this has with the engaged pilasters on either side, the lunettes with the small window above and the entablature above it, enhances the effect of movement like clockwork, according to how the light is shifting throughout the day.

On the right of the exterior of the cupola is also a small sundial set below a lunette on the edge of the roofline facing the courtyard of the Piazzeta Reale, seemingly as a remnant, an exoteric sign, a *gnomon* tracking the movement of the sun. The sunlight in Turin at the base of the Alps is sharp on a clear day—perfect for anyone interested in the precise measurement of time and the movement of the sun or the vast complexity of stars in the night sky.

[18] Guarino Guarini, *Cælestis Mathematicae, Pars Secunda* (Mediolani: ex Typographia Ludovici Montiæ, 1683), 3.; Orsanmichele…; Secendum Mattheum, 3:12. "*Cuius ventilabrum in manu sua et perminunandabit aeream suam et congregabit triticum suum in horeum peleas autem conburet igni inextinguibili*."

18.
Exterior view of San Lorenzo with the Exterior Sundial
Photograph by author, 2018

Ichnography (*della Icnografia*)

Guarini begins *Trattato II: Della Icnografia* (On Ichnography) of the *Architettura Civile*, by stating that the groundplan of a building is "that which creates an open space for the diagram of the sun" (*ex qua capiuntur in solis arearum descriptiones*).[19] The oculus of the Roman Pantheon exemplifies this kind of building by creating a disc of light caused by the entrance of the sun through the great oculus of the dome that moves within the interior space (*symmetria*), shifting with the hours, days and months of the Roman *kalendarium*.

Chapter One begins with the creation of a level foundation (*piano veramente*).[20] The *piano* is determined by hanging a lead weight (*piombo*) just above the surface of the floor and by the principle of gravity the level floor is determined to be at a ninety-degree angle.[21] The lead weight creates an axis point that reaches from the building toward the zenith, uniting practicality with cosmology by aligning with the *axis mundi*.

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[19] Ibid., 63.

[20] Guarini, *Civile*, 38. "*La cagione di questo si è, perchè secondo che i Matematici, e la sperienza dimostrano, ogni peso si la porta per la linea retta, e verticale al centro, cioè per la linea CH nella figura prima, pe la qual cosa se al piombo, ò peso V pendente da N per il filo VN, ed esperimente la verticale HC la linea LN, ò IL sia normale, ed a Angoli retti, allora sarà equidistante all'Orizzonte; Perchè la verticale secondi gli Astronomi cadi al Angoli retti nell'Orizzonte, come quella, che viene dal punto esistente sopra il nostro vertice, che è polo dell'Orizzonte.*"; M. Delambre, *Histoire de l'Astronomie du Moyen Age* (Paris: M[me] V[e] Imprimeur-Librere pour les Sciences, 1819), 522. "*La théorie de cette balance est la même, au fond, que celle de tous les cadrans qui marquent les heures par le seule longueur de l'ombre; on y marque aussi les lignes de l'ashre. Ce cadran est sans contredit un des plus bizarres et des moins sûrs qu'on ait jamais imaginés. On avait sans doute voulu le rendre portatif, mais on aurait aussi bien fait de le tracer sur une longue conna qu'un fil-à-plomb aurait aussi bien fait de le tracer sur une longue canne qu'un fil-à-plomb aurait fait placer verticalement; le gnomon aurait pu se fermer comme un couteau, et se replier dans l'épaisseur de la canne.*"

[21] Guarini, *Civile*, 38. "*La cagione di questo si è, perchè secondo che i Matematici, e la sperienza dimostrano, ogni peso si la porta per la linea retta, e verticale al centro, cioè per la linea CH nella figura prima, pe la qual cosa se al piombo, ò peso V pendente da N per il filo VN, ed esperimente la verticale HC la linea LN, ò IL sia normale, ed a Angoli retti, allora sarà equidistante all'Orizzonte; Perchè la verticale secondi gli Astronomi cadi al Angoli retti nell'Orizzonte, come quella, che viene dal punto esistente sopra il nostro vertice, che è polo dell'Orizzonte.*"; M. Delambre, *Histoire de l'Astronomie du Moyen Age* (Paris, France: M[me] V[e] Imprimeur-Librere pour les Sciences, 1819), 522. "*La théorie de cette balance est la même, au fond, que*

The sky is represented as ACB; the horizon, represented as the circle, is divided down the middle by line AB; the earth represented as H, the equidistant line, from point I, to point L, is the horizon of AB; this describes the levelling of the line and the post [vertical axis] in the floor.[22]

At San Lorenzo the *axis mundi* is determined by the *piombo*, by creating a vertical line which may be drawn from the center point of the floor through the dome and to the top of the lantern. The dome, representing the celestial sphere is aligned by this verticality, which also determines the position of the building to the passage of the sun and the stars in the sky.

In the *Placita Philosophica* the *axis mundi* is referred to as the *polo* and is oriented to the pole star. It becomes like a fulcrum according to its point of orientation (*locus*) which spins into the void (*vacuo*) approaching the infinitity of the asymptote (*asymptotos*) so that "every fixed distance in space may be a location: but nonetheless, the *Polo* (the axis of the celestial sphere) is a fixed point that, and just as time chooses how the heavens move, it is of the greatest significance."[23]

Chapter Two pertains to the *piano veramente* and its proper relation to the horizon. The importance of this becomes clear in connection with Guarini's *Cælestis*, as the horizon relates to astronomy and the rising of star constellations. This chapter, along with Chapter

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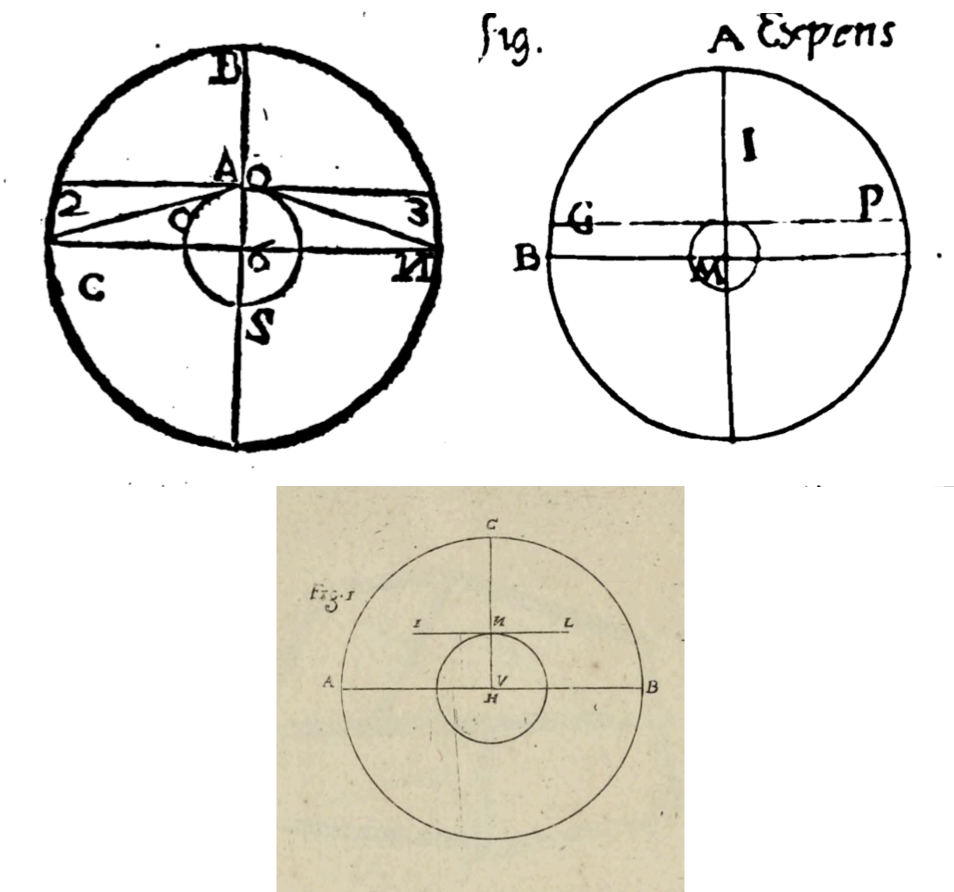
celle de tous les cadrans qui marquent les heures par le seule longueur de l'ombre; on y marque aussi les lignes de l'ashre. Ce cadran est sans contredit un des plus bizarres et des moins sûrs qu'on ait jamais imaginés. On avait sans doute voulu le rendre portatif, mais on aurait aussi bien fait de le tracer sur une longue conna qu'un fil-à-plomb aurait aussi bien fait de le tracer sur une longue canne qu'un fil-à-plomb aurait fait placer verticalement; le gnomon aurait pu se fermer comme un couteau, et se replier dans l'épaisseur de la canne."

[22] Ibid., 38. "*Sia il Cielo ACB, l'Orizzonte, cioè il Circolo, che lo divide per mezzo esprima la linea AB, la terra sia H, la linea equidistante tanto dalla parte I, quanto dalla parte L all' Orizzonte AB sia IL, questa si dirà linea livellata, e posta in piano.*"

[23] Guarini, *Placita*, 274. "*Nota tamen, omnem distantiam fixam posse deservire pro formalitate loci: sumitur tamen, à Polo, sicut tempus desumitur à motu cœli, tanquam à puncto fixo, & magis omnibus noto.*"

Three (*To raise sites with a magnetic compass*) and Chapter Four (*The nature of the site, and its proportion according to the angles of the world*), represent further methods of architectural orientation. Chapter Two involves the measurement of a building upon the surface and cartography of the earth but lacks the cosmological purpose of the other chapters.



19.
Diagrams pertaining to the horizon and the *Axis Mundi*
Top Right: Guarini, *Caelestis Mathematicae*, Tract. 1, Exp. XII, fig. 3
Top Left: Guarini, *Placita Philosophica*, pg. 287
Bottom Center: Guarini, *Architettura Civile*, Table I, Tratt. II

The importance of connecting the *piano veramente* to the horizon becomes clear when the *Architettura Civile* is read in conjunction with the *Cælestis Mathematicae*, because the horizon relates to astronomy and the rising of star constellations.[24] Guarini uses several methods of cartography and geographic orientation to determine how to connect San Lorenzo to the rising of specific star constellations including the use of a magnetic compass (*bussola della calamita*). Guarini describes the compass as a portable solar clock (*un'Orologio da Sole Portabile*) that finds the position of the building in accordance with the stars, by aligning the compass to the meridian.

Disputatio III, of the *Placita Philosophica* (*De Horizonte*), describes the nature of horizon with respect to the rising of stars in the heavens. Guarini states that there are, in fact, two separate horizons (*ergo isti duo horizontes*); our visible horizon from our vantage point on earth and the horizon which divides the heavens into two equal hemispheres (*horizontem semper caelem dividere in duo hemispheria equalia*).[25] At San Lorenzo this applies to the foundation of the site and its alignment with the horizon.

This second, hemispherical definition, brings forth knowledge of the transit of planets between the horizon and the equinox, or the zenith and the nadir. This allows one to arrive at the measurement of days (*mensura tú quantitatis dierum*) as the earth and the planets circumnavigate the celestial sphere due to the physical torque of the sun (*quando gyros, quos circa mundum sol torquet*), revealing the variance of days according to the

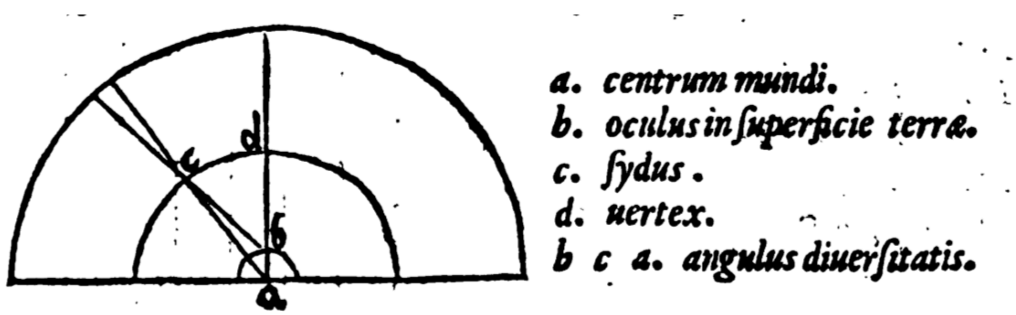
[24] Guarini refernces a problem presented by the astronomer Michael Maestlin involving distortion of rising stars that he solves by aligning the vertical axis with the horizon. Guarini, *Caelestis*, 23. "*Neque dicas refractionem sidera attollere, & ideo fixam in C positam apparere in 2 puncta, & N in 3: quapropter per linear 3 2 rectangulum lineæ rectæ AB post stellas spectari. Respondeo enim refractiones quidem sidera attollere: sed nedum videri è diametro opposta: sed insuper aliquatenum elevata. Ita testatur Mœstilnus sibi accidisse anno 1590.*"

[25] *Placita*, Ibid.

distance and size of the planets (*diesque diuturnitate variat, ut infra*) as the universe circumnavigates the celestial sphere.[26]

By connecting San Lorenzo to the celestial sphere, the *axis mundi* acts like a fulcrum around the physical torque of the sun, revealing the motion of the sun from the earth (*circumeuntis, apparentes oculis nostris*) revealing the variance of days (*mensura tú quantitatis dierum*) according to the distance and size of the planets (*diesque diuturnitate variat, ut infra*).[27]

Book Nine of Vitruvius' *De Architectura* provides a similar schematic in which the amount of refraction that exists when the position of a building on the surface of the earth is aligned with the appearance of a celestial body in relation to the center point being at the middle of the earth. In architecture, this analysis provides a consideration for properly aligning a building with the sun, or with the stars.[28]



20.
Vitruvius, *De Architectura*, pg. 406

[26] Ibid.; Ibid., 304. "*...namque corpora nonrotunda, in gyrú se moventia, in equalibus angulus, modò locum reliquunt, modò occupant; ut videre est, si quadratum in orbem torqueatur.*"
[27] Ibid.
[28] See J.L. Heilbron, *The Sun in the Church*, Cambridge MA: Harvard University Press, 1999.

In the 1550 edition of *De Architectura* with commentary by Nicholas Cusanus, the *axis mundi* is described as a measurement of that which circumnavigates it (*axis mundi est dimetiens, circum quem versatur*).[29] The *axis mundi* provides a basis for measurement and delineation, but also for the demarcation of movement around the point. These two interconnected principles form the relationship between space and time, due to the distance between the earth, the sun, the other celestial bodies and their calculable passage across the sky.

As in his other treatises which involve the knowledge of the celestial sphere, Guarini carefully describes the sphere according to its components, stating that everything within the sphere passes around the center, or celestial pole (*traduci semper per polos alterius*). Guarini states that the sphere is the first astronomical institution (*ex primorum astronomorum instituto*) which because of a mysterious numerical coincidence, embodies the three-hundred-and-sixty-five days of the year, in roughly three-hundred-and-sixty degrees. Guarini delineates time further into minutes (21,600), and into seconds (1,296,000), emphasizing the importance of the precise calculation of time according to the rotation of the earth and its orbit around the sun.[30]

The *axis mundi* coincides with the point in the heavens (*polo*) which creates diurnal movement (*in caelo dantur poli mundi, qui sunt puncta, super quae motus diurnus peragitur*; *linea verò polo coniugens* ED *mente deducta dicitur axis mundi*).[31] The circularity of

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[29] Vitruvius, *De Architectura*, 406.; This diagram in *De Architectura* also represents the difference in position of the horizon from the center point of the earth and its surface. Guarini, *Placita*, 290. "*Prob. Terra respectu firmamenti, ut probauimus, sensibilis non est; ergo horizon sensibilis super terram, & Horizon Astronomicus per centrum terre trásiens sensibiliter nó differút respectu celi.*"
[30] Ibid.
[31] Ibid., 3. "*Linea verò polo coniugens ED mente deducta dicitur Axis Mundi.*"

the sphere signifies the journey of the planets (*cùm ergò circulos signatos itinere planetario in caelo*); the celestial pole (*polo*) is at the center of this journey (*polum quoque ipsorum concipere consequentur opus fuit*).[32]

Geometrically, this celestial passage is described as a circle, the shape which Guarini's *Euclides* establishes as the fundamental form of mathematics within which all other forms are inscribed (*mathematica rerum exordia ex omni parte rotunda, & contornata exiberem*).[33] As in Euclidean mathematics, Guarini moves in succession from point (*punto*), to line (*linea*), to surface (*superficie*); these elements are the lines, angles and geometric figures from which architecture is constructed. The *axis mundi* is represented as a point at the center of the circle.

Chapter Three of *della Icnografia* (*Del modo del rilevare i siti*) pertains to the method of raising the site by connecting the floorplan to the elevation by swinging the lead weight (*piombo*) from the center of the foundation outward in various dimensions. The design of the floorplan is traced upon the foundation according to the dimensions made by the swinging lead weight, creating the outline of the walls of the chapels and pendentives that will be brought up vertically in elevation.

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[32] Ibid.

[33] Guarini, *Euclides* ("Benevolo Lectori"), unpaginated.

21.
San Lorenzo, view of a corner chapel with pendentive above
Photograph by author, 2018

A mason's square (*squadrastabile*), a movable square (*squadramobile*) and a magnetic compass (*bussola della calamita*) are used as tools that measure the dimensions made by the swinging of the *piombo*. A specific method for each tool that is used to demarcate the dimensions upon the foundation is given within this chapter of the *Civile* in succession, moving from simplicity and practicality to cosmology once again.

In Guarini's chapter on determining the proper site of a building (*Del Modo di Rilevare i Siti*) in the *Architettura Civile*, the demarcations are represented upon the surface of a magnetic compass (*bussola della calamità*), which is divided into three-hundred-and-sixty degrees.[34] The magnetic compass differs from the sundial, because it allows the architect to determine the location of a building site and its proportions according to the geographical placement upon the earth (*della natura dei siti, e loro proporzione in quanto angoli del mondo*).[35] Once this location is established, the building may be properly aligned with its solar and celestial coordinates.

The square creates linear and rectilinear dimensions radiating outward from the axis point; the movable square allows one to connect these rectilinear dimensions to vertical points which are conjoined with the building; the magnetic compass is a bit more complicated, involving the use of a three-hundred-and-sixty-degree circumference to create the raising of space for windows and points which demarcate higher points within the elevation.

Chapter Four is a method of connecting the site proportionately to the angles of the world (*Della natura dei siti, e loro proporzione in quanto agli Angoli del Mondo*). Guarini quotes Vitruvius in order to emphasize the importance of the magnetic compass as a method of rationally connecting the building to the movement of star constellations (*Astrologiam, Cœlique rationes cognitas habeat*).[36]

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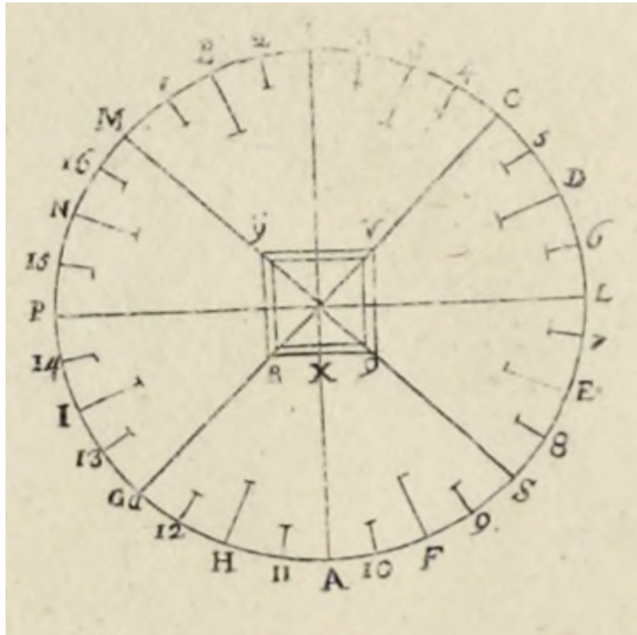
[34] Guarini, *Civile*, 45.
[35] Ibid., 48.
[36] Ibid., 48. "*Meritamente Vitruvio ricerca, che l'Architetto* Astrologiam, Cœlique rationes cognitas habeat *lib. I. cap. I., che sappi Astronomia, e le ragioni del Cielol; perchè sebbene non dee immergersi nello studio di tale scienza, dee però saperne tanto, quanto basta a conoscere la posizione de' siti, e le sue qualità, per potere, secondo richiede la natura de' siti, così accomodare I disegni. Per darne adunque una prima cognizione.*"; Vitruvius, *De Architectura* (Strasbourg: Ex Officina Knoblochiana, Per Georgium Machaeropieum, 1550), 6. "*Astrologiam cœliq; rationes cognitas habeat.*"



22.
Guarini, *Placita Philosophica*, pg. 397
Photograph by author, 2018

The first observation pertains to the celestial sphere which is like the globe that represents the earth but rather the stars around it as well as astrographic points of origin: the Equator, the Zodiac, the Horizon, the Meridian and the two Tropics. This method of connecting the building to the universe through what Guarini calls the rationality of the heavens (*ragioni del cielo)* is expounded upon within many of his treatises, including the *Placita Philosophica*, *Euclides Adauctus*, the *Modo di Misurare le Fabbriche*, *Compendio della Sfera Celeste*, *Caelestis Mathematica*, and the *Leges Temporum et Planetarum*.

The *Placita* states that the philosopher creates a simulacrum between the architectural floorplan of a building and the map of the heavens (*aethereae domus icnographium describere debeamus*).[37] *Disputatio V*, On the Movement of the Celestial Sphere (*De Motibus Spaerarum Caelestium*) describes the movement of planets and stars around the sphere

[37] Guarini, *Placita*, 287.

as a computational machine (*figuris machinamentisque*) based on the principles of mass and physical momentum (*computum extrahere, nec planetarij laboris mensuras obtinere possimus*).[38] The celestial sphere as a machine relates to time (*orologia*) and to movement (*macchinaria*), the second and third premises of Guarini's theory of architecture.[39]

The *Placita Philosophica* also references Johannes Kepler (1571–1630) and the Carthusian polemist Lanspergius (John Justus of Landsberg, 1489–1539), referring to their knowledge of the universe as being in constant and perpetual motion.[40] Diameter, sphericity, and eccentricity of the movement of heavenly bodies, translates into the geometries of Guarini's architectural design by creating an interior space where one experiences the movement of a mechanical universe.

Chapter Five pertains to further intricacies involving methods of *disegno* that are traced onto the *piano veramente*. The use of the magnetic compass is also explained in terms of how to connect cartographic measurements to the design upon the foundation. Guarini also explains how drafting upon the surface of the foundation begins to create plans with which to create the pilasters, columns and walls of the elevation that are covered in Part Three. The quality by which these figures should be drawn in order to lay out the elevation are covered in greater detail throughout Chapters Six and Seven.

The last chapter of Book Two, *della Icnografia*, begins with the art of creating a column as well as how to create a round or an elliptical peristyle colonnade in proper and

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[38] Ibid., 326.
[39] Ibid., 346. From *Expensio VII: De Tempore Solari*: "*Notandum est igitur, tempus Solare distingui communi hominem voce, in Dies & Annos.*"; Ibid., 353. From *Expensio VIII*: *De Motibus Lunæ*: "*...annis etiam Lunaribus tempus mensurate…*"
[40] Ibid., 330. "*Probatur primò, experientiâ. Namque in observationibus Kepleri, Lanspergii, & aliorum, quandoque, immò saepè saepiùs Planetæ non errant in eo situ…*"

harmonic proportion. The chapter proceeds with a geometric demonstration as to how to layout the floorplan for a peristyle in mathematical proportion.

Guarini's design for San Lorenzo utilizes the principles of peristyle in the columniation around the perimeter of the worship space, where there are columns at the corners of each of the chapels and at the front and the rear of the altar space. While Guarini's use of columniation differs from his description in the *Civile*, the same method of mathematical and harmonic proportion is utilized by generating the layout of the columns through the intersection of oval and circular geometries.

Elevation (*Dell' Ortografia Elevata*)

Book Three (*Dell'Ortografia Elevata*) discusses the elevation of the building and its geometric projection. Guarini's orthographic method is Vitruvian in origin, stating that the elevation is determined first by a rationally designed floorplan (*erecta frontis imago, modicéque picta rationibus, operis futuri figura*).[41] He places an emphasis on the interaction of shadow and light (*ombreggiata*) which play upon the floor, so that the shadows express where solid forms will be, allowing light to penetrate the areas which remain open. He continues on to describe the connection between orthography and projectional geometry (*sporti di projectiones*), stating that the swinging of the *piombo* generates the forms of orthographic design of floorplan and elevation.[42]

Book Three is counterintuitive in terms of architectural practice in the sense that Guarini moves from specificity to generality, from ornamentation and detail to the larger structural features which uphold the elevation, including the vaults, triangular lunettes and the drum of the dome. The elevation is determined by theoretical, mathematical principles and their application to columns, plinths, ornamentation and onto larger forms in a manner that architecture is in service of his work as a mathematician, applying intricacy to each ornament within a microcosm and working outward to the totality of the architectural work.

Chapter One consists of a number of observations involving the intricacies of columniation and the design of the capitals, delineating between each specific aspect of the

[41] Guarini, *Civile*, 73.
[42] Ibid. "…cioè immagine d' una facciata elevate, destramente ombreggiata, che rappresenta le simmetrie, ò le ragioni de future Edifizio…"

column, varying composition and form. He also describes how the forms fit together from the primary point created by the *axis mundi* and the swinging of the *piombo*. The planar division of these forms also becomes a form of shadow projection as well, which is related to projectional geometry and gnomonics. The projection of the shadow and its form is proportionally equivalent; in gnomonics, the angle of the style is equivalent to the geographic latitude of the sun.

23.
Euclides Adauctus, pp. 140, 141

Guarini begins with the design of columns by describing the elements of the Ionic order. He begins by defining the geometry of the *echinus*, which is a round cornice at the top of the column just below the abacus which is typically square. At San Lorenzo, most of the columns are Corinthian, therefore the *echinus* is found below the acanthus (*acanto*) and volutes (*corpi spirali*). Above this level of the order is the *cyma*, otherwise known formally in Guarini's treatises as the *cymacia coronides*.[43]

The mathematical purpose of the *cymacia coronides* is to point in the direction of the projectional plane (*proiectionem dicimus figuram*), like the demarcations on the surface of a sundial. The detailed grammar of the Ionic Order also uses egg and dart patterns, lozenges or other motifs upon the *echinus* to demarcate this mathematical relation to the rest

[43] *Civile*, 75. Sometimes spelled *sima* or *simacium*, Guarini speaks of the *cyma* as related to Greek architecture and to the throat or *gola* of the column.

of the building. The Corinthian capitals at San Lorenzo are demarcated on the base of the acanthus leaves on each capital. The detail of each column has a theoretical purpose, by mathematically connecting it to everything else in San Lorenzo.

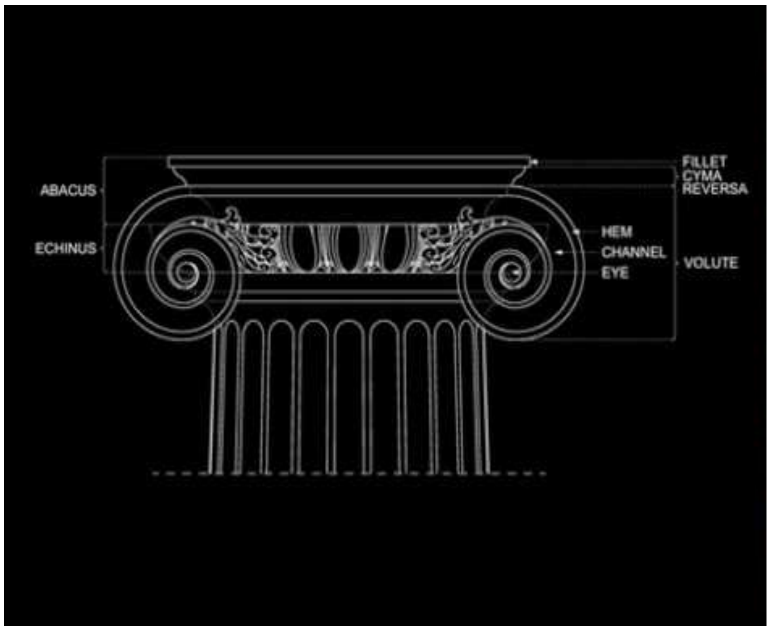
The mathematical relationship between the *cymacia coronides* creates a *lemma* that connects theoretically to the *Euclides Adauctus* and the *Cælestis Mathematicæ. Tractatus XXVI* of the *Euclides* pertains to projective geometry (*De Proiecturis*); *Pars Prima* to orthography (*De Orthographia*) and *Pars Secunda* to stereography (*De Stereographia*).[44] Projective geometry serves as an extension of the principles presented in *Euclides* as well in which the principles of gnomonics are connected to horology (*tum horologijs, tum instrumentis mathematicae*), the astrolabe, quadratics and cosmography (*astrolabio, & quadrantibus: tum cosmographiae*).

Guarini directly applies the mathematics of the *coronides* to larger aspects of the building in subsequent chapters as well as in the context of orthographic projection (*maximè architecturae ad proicienda corporum*). The planes of extension that are created through the design of column capitals connect to the oculus of the building and to the universal schema of San Lorenzo (*ocularis prospectus representatur in planum extendere oporteat, & ipsa quoque corpora, superficiesque in planum proicere*).[45]

It is the sun that defines projection (*solet definire proiecto*), but without the shadow cast by the gnomon, form and structure cannot exist. It is not possible for that which is impermeable to light to transcribe form; the sun itself is a single surface that is beyond transcription (*siquidem res solida nunquam potest in planum transcribi; sed solùm illius

[44] Guarini, *Architettura Civile*, 73, 191. *Trattato III*, *Della Ortografia Elevata*, and *Trattato IV*, *Della Ortografia Gettata* of the *Architettura Civile* are mathematically connected to the orthographic principles presented in *Tractatus XXVI* of the *Euclides*.
[45] Guarini, *Euclides*, 444.

singulae superficies: quibus super planum descriptis; deinde res ipsa solida representatur), thus allowing the intellect to perceive its dimension (*licet hoc sensu intellecta, vera evadat; aptiùs tamen videtur definienda*) as the form and structure of the building is reflected upon the surface of the projected light.[46]



24.
Glossary of an Ionic Capital.
The *Cymacia Coronides* in Guarini, *Architettura Civile*, *Lastra II*,
represented here as the cyma

Guarini defines orthography and stereography as two types of projective geometry; orthography being caused by light which is projected through a rectilinear form, such as a pyramid; stereography being that which is caused by light projected through a circular

[46] Ibid.

form, such as a cone.[47] Orthography is not based on the infinite perception of the eye (*orthographia non nascitur à distantia oculi infinita*), but rather upon the impression of visual lines which depart from their origin (*plani primigenij descedentes*).[48] Distance is based on the totality of its foundations (*distantia quoq totius subiecti*); the projection of orthogonals is unchanging and immutable (*licet in orthogra hia nihil immutet*) from the point which generates those foundations.[49]

The foundation of stereography is in the division of planes upon the surface of that which the eye perceives (*stereographiam oculum tribuentem*); a foundation which emanates from the center of the sphere from which it generates (*centrum stereographum admittitur ipsam super speram*) at a point within the pupil (*pro pupilla*).[50] Stereographic projection generates from the center of the sphere, rather than by way of the orthographic assemblage of surface planes and is, therefore, not a subject that is perceived before the eye as the instrument of vision (*ergo descriptio haec non pendet ab oculo*) but is instead perceived within it at its core.[51]

Expensio II of the *Euclides* elaborates on the concept in the *Praeliminares* concerning the extension of the core which, in this case, is applied to a center point (*punctis indivisibilis*).[52] The figure provided describes two concentric circles, the perimeter of one set

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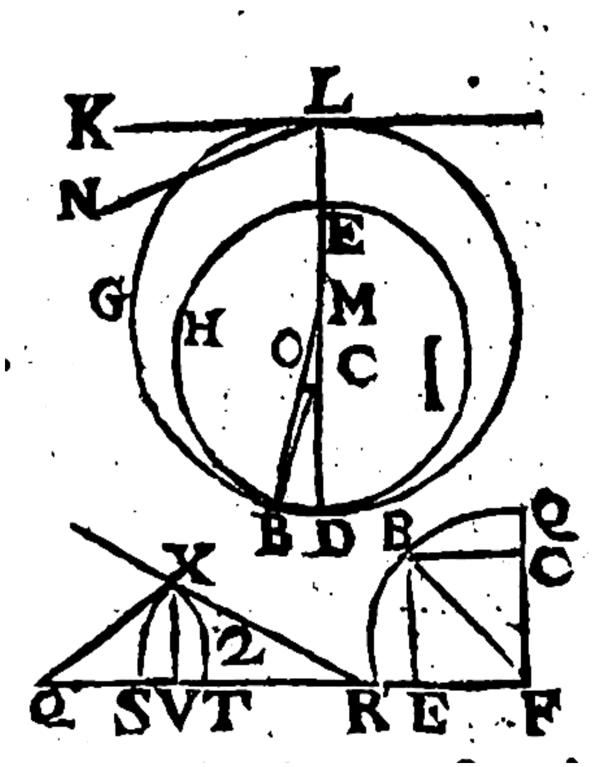
[47] Ibid., 445. "*Probat. auctoritate Mathematicorum, qui ita sufficienter divisisse proiectionem arbitrari sunt, tum quia superficies, que aliam ambit duplex solùm esse potest, nempe sibi, fuisque partibus parallela, ut prisma, & Cylindrus. Aut non parallela, sed in unum punctum contendens ad instar coni, aut Pyramidis; si superficies illa sit parallela sibi, fuisque partibus, dicitur eius impressio facta in plano orthographia: si verò sit ad modum pyramidis, vel coni in punctuque conveniat, dicitur Stereographia, et hinc utraque definietur.*"
[48] Erwin Panofsky, *Perspective as Symbolic Form*, trans. Christopher S. Wood (New York: Zone Books, 1991), 35. Panofsky refers to the difference between orthography and stereography by comparing the linear perpective of the Renaissance, to 'antique' optics, such as that of the Middle Ages, and of Euclid, which "conceived of the field of vision as a sphere."; Ibid., 444.
[49] Ibid., 445.
[50] Ibid., 445.
[51] Ibid.
[52] Guarini, *Euclides*, 2.; Euclid, *Elements*, 155. "A point is that which has no part (*Σημεῖόν ἐστιν, οὗ μέρος οὐθέθῖν*)."

against the other connected by two radial lines; one meeting at the centerpoint of the smaller circle, and one at the larger. These two radii create an axis point and a fulcrum (BDM), causing the movement of the smaller circle around the perimeter of the larger circle (*circum ductis à centro lineis ad omnia puncta circonferentiae circuli maioris, illa necessariò transfirent per tot alia puncta circuli minoris*).[53]



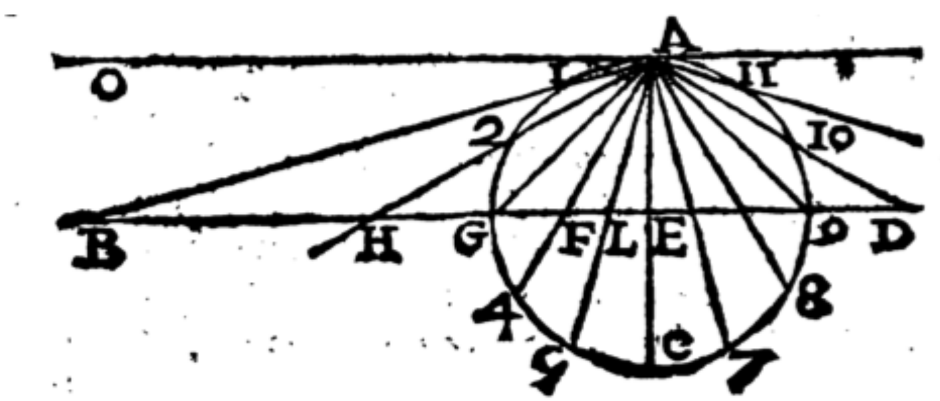
25.
Stereographic projection from the center of a sphere
Guarini, *Euclides*, pg. 3

The lines K and N, as connected to L, create a second axis point, which cause the movement created by the interaction of the fulcrum BDM, bringing the planar dimension of the two concentric circles into the form of a sphere, the center point of which is now L.

[53] Guarini, *Euclides*, 4.

This is Guarini's answer to the geometry of the indivisible point (*puncta indivisibilia*), because it is expandable to an infinite quantity without the separation of form and without the separation of the foundation (*subiecto*) to uphold the mass and weight of the architectural structure.[54]

Guarini defines orthographic and stereographic projection as being transmutable according to the positioning of form, plane and distance (*tria proiectionem immutant, situs rei, situs plani, & eorum distantia*).[55] Distance, however, is orthographically immutable (*distantia quoq totius subiecti, licet orthographia nihil immutet*), while stereography greatly alters the magnitude of forms (*stereographia tamen valdè figuras alterat, & in diversam magnitudinem diducit*).



26.
Diagram pertaining to stereographic projection on a plane
Guarini, *Euclides Adauctus*, 454

[54] Ibid., 3. "*Omnis quantitas si augeatur in ifninitu potest quá cumque datam superare, sed angulus contactus circuli cum plano, licet auctus in infinitum.*"; Guarini points out that Galileo also created a theory of the indivisible point as well but didn't base it on the interaction of two divisions, or concentric circles.
[55] Ibid.

The relationship of Guarini's theory of projective geometry to gnomonics becomes evident in a closer examination of his Latin, in which "*distantia quoq totius subiecti*," pertains to the totality of distance that is subjected to the immutable nature of rectlinear, orthographic lines and planes. A *subiectum* is also defined as the base-plate of sundial, a definition applied by Vitruvius in which he states that the foundation (*subiecto*) of the aperture of a building is of a greater length and width than a column or shaft upon the surface of the floor (*subiecto foraminum* [*sic*], *latitudinis et crassitudines eiusdem, cuius minor columna illa*). The floor acts as the plate of the sundial, as in the example of the disc of light which enters through the oculus, circumnavigating the floor of the Pantheon.

In Book Nine, Vitruvius also states that the entire measurement of time is described upon the sundial's plate according to the analemma, the latitudinal diagram which shows how the length of the shadow changes with the time of year (*subiecti onibus rationes horarum erunt ex analemmatos describendae*).[56] The plate of the sundial involves stereographic projection onto a flat surface (*circulus parallelus plano stereographo proiectus est circulus maior*), which becomes three-dimensional with the coincidence of sphere and the conic section.

The projection of circular surfaces including ellipses and spheres (*de proiectione superficierum circularium*) is a geometrical language of immense applicability (*fermo est, quae immensos usus habet*) including gnomonics (*gnomonica*), architecture (*architectura*)

[56] Glare ed., *Oxford Latin Dictionary*, 1840.

and perspective (*prospectiva*).[57] The projection of circular and ellipsoidal surfaces into volumetric figures creates cylindrical, parabolic and hyperbolic surfaces (*cylindros parabolicos, & hyperbolicos*).[58]

Pertaining to volutes (*corpi spirali*): *Expensio III* enumerates several undiscovered mathematical problems concerning the indivisible point. Guarini begins by dividing the point into two equal parts using a line (*secari lineam novum punctorum in duas partes aequales*).[59] The two points extended into a line rotate concentrically like the movement of a compass to create a circle (*quòd datis duobus punctis concentricis tot reperirentur puncta*).[60] Diagonal lines extend downward from the point creating a square (*diagonalis in quadrato effet tot punctorum quod latus; cùm ductis a punctis omnibus laterum parallelis, per omnia diagonalis puncta transfirent*).[61]

The concentric rotation of the indivisible point and its diagonal extensions form the model of a hyperbola and as the indivisible point rotates, it forms an asymptote, a concentric spiral that tends toward infinity (*quòd hyperbole semper ad asymptotos accedit*).[62] The finitude of the indivisible point is expanded to infinite (or near infinite) quantity through the model of the hyperbola (*puncta finita in infinitum in quantitate*).[63] Hyperbolic geometry is elaborated further in Guarini's theory of conics (*Tractatus XXIV* and *XXV*).

This geometry demonstrates the even structural distribution of weight in the construction of architecture as well as the symmetry of design, allowing the spherical expansion of a structure such as a dome, a vault, an arch, or the dimensions of any part of a

[57] Ibid., 449.
[58] Ibid., 450.
[59] Guarini, *Euclides*, 4.
[60] Ibid.
[61] Ibid.
[62] Ibid., 5.
[63] Ibid.

building. However, it can also represent a model of the *axis mundi*, the fulcrum being created by the mass (*molis*) of the smaller circle being pulled (*tractatum*) around the larger circle. This geometric model echoes Guarini's theory in the *Placita Philosophica* of the sun pulling on the moon as it orbits the earth, a theory that prefigured Newton's Theory of Universal Gravitation.[64]

[64] See page 87.; Guarini, *Placita*, 506.

27.
Interior, San Lorenzo, showing the structure of a column and the symbolic use of light
Photograph by author, 2018

The spherical expansion of light within the building allows for symbolic orientation to occur, as the sculptures and ornamental details are struck by the sun's rays at different locations throughout the day. This can be clearly seen in the sculpture of the Annunciation, as light begins to permeate the space between the Angel Gabriel and the Virgin Mary, light which will at times strike the angel's finger pointing the way to the Incarnation.

Book Three moves on to larger forms and structures beyond columniation, including the vaulting, lunettes and the drum which upholds the dome. The geometries Guarini applies to this aspect of San Lorenzo's geometry pertains directly to Book Five of the *Euclides Adauctus* and to the second book of Euclid's *Elements*. The generative equipotentiality of lines (*In Secundum Librum Euclidis de aequipotentia linearum*) and the equipotentiality of a parallelogram is discussed in light of the science of shadow projection and gnomonics. The significance of this is where a diameter bisects the parallelogram, forming two opposing triangles, reflecting light and dark like a mirror onto one another.[65]

The triangle is significant because it is the foundation and universal structure which facilitates the generation of all other geometric forms. The base of the triangle is upheld equilaterally and brought to a point by its two other angles (*hinc est universaliter, quòd si detur triangulum habens duo crura innixia eidem basi*).[66] Guarini's theory of the triangle involves the shadow cast by the equilateral triangle in a circular motion and involving the potentiality of semidiametrical expansion through the propagation of the circles which

[65] Guarini, *Euclides*, 54. "*In omni parallelogramo unumquodque eorum, qua circa diametrum sunt parallelogrammorum, cum duobus complimentis, Gnomon vocetur. Dicit in parallelogramo AGCM, unum parallelogrammum diametrum AB ambiens, V.g. nigrum cum duobus complimentis albis DC, & DG vocandum esse Gnomonen; Vel nigerrimum minus, cum duobus complimentis ijsdem Gnomonem appellari.*"
[66] Guarini, *Euclides*, 34.

overlap, creating their formation (*ed ideò noluit id inter postulata exquirere, tanquam concedibile; cùm hac proprietatem aequalium voluerit demonstrare; quod scilicet potentiâ sint eiusdem circuli semidiametri*).[67] This Euclidean demonstration relates to the function of the gnomon, which is triangular and casts a shadow upon the hour of the day and the time of the year that is inscribed upon the dial.[68]

The potentiality of lines extends to the use of triangular divisions to allow the connection between two rectangles at various declinations (*De potentiâ laterum triangulorum*). When a line is extended from the middle of a rectangle that is parallel with its side, and lines are drawn to meet it at a point, this forms a triangle, from which may generate two other rectangles, connected to its vertices (*in triangulis rectangulis quadratum, quod à latere rectum angulum substendente describitur, æquale est duobus quadratis, quæ à lateribus angulum rectum continentibus describintur*).[69] This theorem is expanded, using obtuse (*amblygonijs*) and acute (*oxigono*) triangles, as well as the creation of the trapezoid, using a curvilinear extension between the two opposing points of rectangles which are extended from the triangle.[70]

These theories connecting astronomical bodies, the projection of shadows and architecture create a simulacrum of light, its projected shadow and the architectural form.

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[67] Ibid., 35.

[68] Thomas Da Costa Kaufmann, "The Perspective of Shadows: The History and Theory of Shadow Projection," *Journal of the Warburg and Courtauld Institutes* 38 (1975): 263. "By measuring the length of shadows cast by gnomons and reasoning from the geometry of similar triangles, an altimetric procedure employed by Euclid among others and said to date all the way back to Thales, astronomers attempted to determine the distance of the sun from the earth."; Kircher, *Ars Magna Lucis*, 144. "*Ars Gnomonica es certa, & demonstrativa motuum cælestium in quolibet plano, aut superficie per gnomonis umbram repræsentandorum facultas.*"

[69] Ibid., 58.

[70] Ibid., 61.

The floorplan of San Lorenzo becomes an inscription of the 'shadow' of the sun, tracing its movement across the sky.

Guarini also describes this relationship between the sun and its shadow in *Disputatio III, De Figura Caeli*, of the *Placita Philosophica*, stating that the movement of the sun creates a sundial as its projected rays hit the surface of a plane (*Quarum prima desumitur ab horologijs solaribus, quae aut sunt rotúnda, aut circuli in planú super aliquam superficiem proiecti*).[71]

Tractatus VI of the *Euclides* pertains to the third book of the *Elements* which focuses on the circle, the figure which is the origin of all geometry. The circle is the generative principle of all integral and constructed shapes, including the triangle, square as well as curvilinear lines, which generate the formation of hyperbolae, parabolae, ellipses, spheres and conics.[72] Several demonstrations commence, which all generate from the point at the center of the circle and how it may be extended in various dimensions to create simulacra of a circle, which then extends rectilinearity forth, forming the potentiality of other forms (hyperbolic, parabolic, etc.).

There is an optical basis for such linear extensions that is created by convexity and parallax, by bending the periphery of the circle to reflect upon itself, like a lens (*si extra circulum sumatur punctum quodpiam, & ab eo ducantur rectæ, una per centrum transiens, reliquae aliae in causam peripheriam, vel convexam*).[73] This concavity is created by the

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[71] Guarini, *Placita*, 304.
[72] Guarini, *Euclid*, 63. "*Egit in duobus primus Libris Euclides de primo genere superficierum; nimirum de rectilineis, & non quidem de omnibus; sed solùm de præcipuis, & quæ alias figuras planas integrant, & componunt, ut sunt triangula, & quadrangula, nimirum, ut eas solùm, quæ erant elementares attingeret: In hoc verò tertio Libro agit de circulis, quæ figura est origo, & principiùm omnium linearum flexarum, puta Hyperbolæ, Parabolæ, Ellipsis, aliarumque similium, ut sicuti rectilineorum Elementa, & flexorum quoque doceat, his enim principijs ferè omnia fundatur, quæ tum de sphera, tum de sectionibus conicis ostendentur.*"
[73] Ibid., 72.

collapse of the peripheral concavity, due to the extension outward from the center of the circle (*extra circulum, & ex eo in concavum peripheriam cadens recta transeat per centrum*).[74]

Tractatus VII pertains to Book Four of the *Elements*, and, to the inscription and circumscription of the circle (*In Librum quartum Elementorum. De inscriptione & circumscriptione figurarum in circulo*). As a progression from *Tractatus VI*, Book Four forms a comparison between the circle and other solid figures, thus developing the figure of the circle into a solid Archimedean sphere.[75] The extension of a line within the figure, a triangle or rectilinear form, multiplies the form of the circle by shifting its axis point. Differently than the previous demonstration, the shifting of the axis connects the two circles which double to form a solid (*insistens erunt duplicia*).[76]

The duplication of geometric forms within the circle is also a reference to Clavius, in which he theorizes on the amount of multilateral, equilateral and equiangular figures that may be repeated within the form of the circle (*reperire figuras multilateras, aequilateras, & equiangulas*).[77] The inside periphery of the circle is divided into fifteen angles (*quindec-*

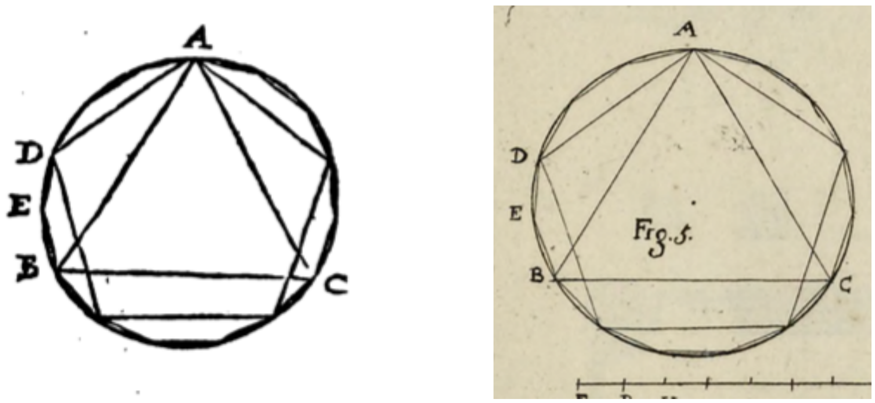
[74] Ibid.

[75] Ibid., 83. "*Liber quartus agit de descriptione figurarum respectivè ad circulum; licet enim triangula, & quadrata possit sine circulo describi, commodiùs tamen cum reliquis figuris, aut intra circulum, aut circa circulum describuntur. Usus verò huius Libri pernecessarius est, tum solidis in sphæra inscribendis, & circumscribendis, tum ad comparationem externæ figuræ solidæ, cum interna, ex qua Archimedes soliditatem sphæræ adivenit, tum ad lineas, chordasque arcuum inveniendas, & tandem ad Militares delinationes fortalitorum.*" Noted at the end of the previous note, reference to Archimedes pertains to the use of spherical geometry for military fortification, connecting Guarini's Euclidean knowledge to that of the *Trattato di Fortificatione*.; Ibid. "*Antequam propositiones ipsas aggrediamur aliqua principia, definitionesque ad hunc librum, spetialiter spectantes oportet agnoscere; istæ verò sunt.*"

[76] Ibid., 87.

[77] Ibid., 91.

agoni), which are divided into the pentagon and the triangle, intersecting at various equidistant arclengths (*probatur tres arcus, quibus anguli trianguli insistunt, vel quibus latera equalia subtenduntur*).[78]



28.
Diagram depicting the fifteen angles within a
circle divided by the pentagon and the triangle.
Left: *Euclides Adauctus*, 91; Right: *Architettura Civile*, Tav. 1, Fig. 5.

The purpose of elevation involving the use of vaulting, lunettes and the tondo pertains primarily to the level of the clerestory at San Lorenzo. The tondo in terms of elevation, however, is not the drum of the dome, but rather the measurement that can be made from the top of the dome to the floor, including the optical concavity discussed by Guarini in the *Civile* and the *Euclides*, which furthers the effect of sunlight upon the surface of the floor as a sundial. The apex of the triangle can be seen in relation to the other generating forms that create a *directrix* for light within the space and the physical movement of the church around the sun.

[78] Ibid.

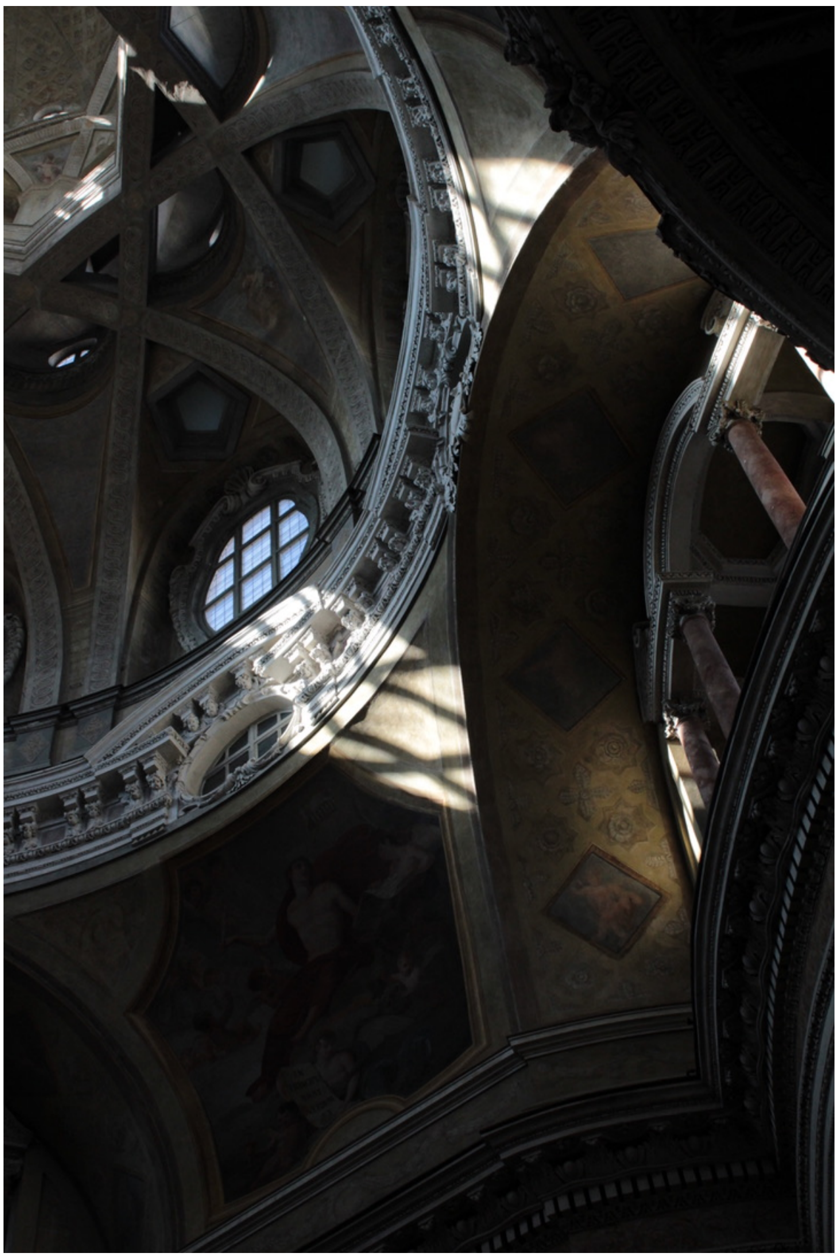
Orthography (*della Ortographia Gettata*)

Book Four of the *Architettura Civile* pertains to orthographic projection (*Della Ortografia Gettata*). Orthographic projection involves projective geometry which creates an amplification of longitudinal and latitudinal planes to create unified architectural form. Mathematical instruments are used in this chapter which facilitate the 'instrumentation' of San Lorenzo's dome to function as an astrolabe. Optical theory and scenography are interpreted through the eye as the instrument of vision, itself a substance extended into the ordered structure of projected planes.[79]

Guarini's studies of orthography in Book Four create a progression of shapes and forms which are seen at oblique angles to form Euclidean equations subsequently involving conics and spheres. The demonstrations that follow remain abstruse without the aid of the *Euclides Adauctus* to create an understanding of mathematical reasoning as well as the *Cælestis Mathematicae* to form an understanding of the *lemma* created through the teleology of forms within San Lorenzo, the connection of the church to the movement of the universe and the celestial sphere.

[79] Guarini, *Euclides*, 444. "*Proiectionum usus amplissimus; tum horologijs, tum instrumentis mathematicis, V.g. Astrolabio, & Quadrantibus: tum Cosmographiæ in planum ad circulos longitudinis, & latitudinis proiciendos, & tandem, & maximè Architecturæ ad ta perutilis. Et hinc prospectivæ, cùm priùs illud, quòd iuxra diminutionem ocularis prospectus representatur in planum extendere oporteat, & ipsa quoque corpora, superficiesque in planum proicere.*"

The demonstrations of Book Three involving the stereographic geometry involved in the creation of columns and their capitals is brought to fruition within the third dimension. The circle becomes the sphere; the line becomes the cone within the dimensions of the clerestory as we work our way into the light of the sun through the dome and the lantern.



29.
San Lorenzo, view from the clerestory up through the dome to the lantern
Photograph by author, 2018

The equations found in the *Euclides Adauctus* involve the relationship between light and form as it enters through the lantern and the dome and down into the clerestory to the church floor that fortifies Guarini's *praxis* within the *Civile*. The principles of orthography define the importance of moving from parallel plane to oblique angle in determining the expression of architectural form (*determinata maniera di espressione*). The interpenetration of forms (*copulazione*) is the key to orthographic projection, created between the circle and the projection of the ellipse by way of a linear extension (*adiectam extra circulum*).[80]

Guarini relates the origin of stereography to the projection of a corporeal sphere, which is thereby established in relation to his architectural theory as the celestial or universal sphere. The celestial sphere revolves around the luminous body (*corpus celeste luminosum circa sphaera se volvens*), creating corporeal opacity (*corporum opacorum*) as radiant light invades the limits of darkness (*radijs incurrens tali modo umbras*).[81]

As all dimensions are created through the interpenetration of light within the sphere, Guarini begins with the interaction between cylindrical form and straight lines, stating that it creates a concavity upon the flat surface of the foundation. The term for straight lines or right angles (*rete*) is the same term used for the part of a spherical astrolabe which creates the flat or planar dimension within spherical space.

[80] Guarini, *Civile*, 191.
[81] Guarini, *Euclides*, 452.

The cylinder also relates to the orthographic forms which make up the vertical and curved dimensions of the chapels and the clerestory, which Guarini defines as semicylinders which fold back upon themselves (*semicilindro ricercato*).[82] These forms at San Lorenzo also appear within the exterior of the dome as vertical convexities with scallop-shaped windows with small eyelet windows and low colonnades. Springing forth above it we find the lantern and *cupolino*, adorned with vertical lunettes like the petals of a geometrical flower. The windows within the *cupolino* echo the lower vertical order of the exterior of the dome, reflecting once again the idea of time and movement like the face of an astrolabe or pocket watch.

30.
San Lorenzo, view of the cupola, showing fenestrations demarcating time
Photograph by author, 2018

[82] Guarini, *Civile*, 205.

The apex of the lantern is the point at which the *axis mundi* points to the zenith and is also what is called the throne of the spherical astrolabe. From the beginning of laying the foundation, the *piombo* is hung in vertical alignment with what will become the apex of the lantern, pointing directly downward to the center point of the floor. Inlaid upon the floor of the church directly below the lantern is the symbol of a compass with eight cardinal directions.

San Lorenzo is designed in a similar manner mathematically as the Pantheon, in which the light projected through the oculus creates concavity within the ichnographic floorplan. The sun's dimensions are caught through the oval-shaped windows within the dome that move around and catch the sunlight at varying degrees along the drum of the dome. The drum of the dome at San Lorenzo is in relation to the edge of the tympanum of an astrolabe. The term for the *rete* is in relation to the Latin for *aràneum* meaning "spider's web." The effect of light through the frame of the scallopine windows in the dome creates this effect upon the tympanum, both upon the drum of the dome and also as light refracts along the surface across the dimension within the drum, creating a brilliant and mysterious effect of sunlight and cosmos.

The geometric relationship between sphere, cylinder and conics is the form created by the light of the sun as it enters through the fenestrations of the dome, penetrating the church with the glorious mystery of the sun and the night sky. On the level below the drum of the dome is a system of pendentives which are broad at the base with semicylindrical vaulting and fenestrations. The geometries of the dome and the pendentives relate to the movement between cylinders and conics in the *Civile* and involves the most complex exploration of the interpenetration of forms within the *Euclides Adauctus*.[83]

31.
San Lorenzo, view of light permeating the dome, demonstrating the interconnection between '*areanum*'
Photograph by author, 2018

Guarini's analysis of conics is exquisite, providing a spatial understanding of the geometries connected to the parabola and hyperbola as well as connecting them to the theory of gnomonics (*gnomonem*), represented by quadrangles (*quadratum*) that extend from

[83] Compán, Victor, Margarita Cámara and Francisco Gonzáles de Canales, "The Geometric Principles of Warped Rib Vaults in Central European Baroque Architecture from Guarini to the Dietzenhofer Family and Balthasar Neumann" in *Nexus Network Journal* 17, 1 (2015): 193.; Nikolaus Pevsner, "The Three-Dimensional Arch from the Sixteenth to the Eighteenth Century" in *The Journal of the Society of Architectural Historians* 17, 4 (1958): 22.

the *umbelicus*. Guarini applies the term *permutando*, emphasizing the transformational nature of light in relation to movement in his system of geometry, which leads to a careful analysis of the asymptote (*de asymptoto hyperbolarum proprietate*).[84]

The study of conics (*De Sectionibus Conicis*) in Guarini's *Euclides* is accredited to Apollonius of Perga (*huius verò mirabilis cognitionis promotor, & ampliator fuit Apollonius Pergeus, qu ob id principis geometrae nomen consecutus est*).[85] Apollonius advanced the study of geometric principles involving conics and their sections which create triangular, circular, hyperbolic and parabolic forms.

In observing the conical projection of a shadow cast upon the moon by the earth (*umbra terre sit conica, nempe tanquam pyramis in acumen finiens*), Guarini discusses the movement of shadow and the dilation of light across its surface (*quiá umbra perambulat, ubi dilata magis est*).[86] Guarini expresses a fascination with the effects of illumination from the sun (*illuminans*) and the reflected light of the moon (*illuminata*) as well as how the use of *quadratura* can determine the variation of these effects. The use of conics to determine effects of the sun casting a shadow from the earth onto the moon, is elaborated further in the *Euclides Adauctus*, connecting to the intricate study of light through fenestrations in the dome of San Lorenzo and in the geometry which forms the structure of the entire church.

The distinction made between the geometry of the parabola and the hyperbola in relation to the light of the sun through the dome is important in relation to the movement of sunlight within the church and the infinitude of the asymptote. A parabola is a conic

[84] Guarini, *Euclides*, 416.
[85] Ibid., 390.
[86] Guarini, *Placita*, 308.

form which ends at the point of its axis, which is the apex of the lantern (*planum secant parallelum uni lateri sectionis per axem adigitur*). A hyperbola contains planes which continue through the axis point, creating vertices which face the opposite direction (*planum secet utrunque conum ad verticem erunt opposite figurae*), thereby connecting with the external movement of light exterior to the church and acting as a fulcrum to move the sun within the interior space.[87]

The asymptote is an aspect of the infinite created by the expansion of the singular point of light (*datus eius asymptotis, & unico eius puncto*). The expansion of the point in Euclidean geometry is the initial formation of an ellipse that is described in the *Civile* and in Book Six of the *Elements*. The asymptote expands as a point of light within two tangential planes or axis points formed along the chord (*quadrate segmentis chordae*) of the ellipse.

The ellipse moves beyond the perimeters of the hyperbola (*extra conum extenso efficiunt*), increasing the potential of mathematical comprehension (*inutilis contemplatio*).[88] The position and function of the *umbilicus*, a point at which the curved surfaces of a hyperbola are equal to one another (*umbelicus est quoddam punctum intra sectionem, quod insignes proprietates obtinet, maximè ad ipsarem sectionem*), relates to the importance of the asymptote as well in the creation of *symmetria* within architectural forms.[89]

Guarini creates a parametric set of equations (*parametrum*) that describes the formation of ellipses caused by the binary movement of the two axis points (*focos*). The interaction between hyperbola and ellipse provides a description of an intricate geometry of

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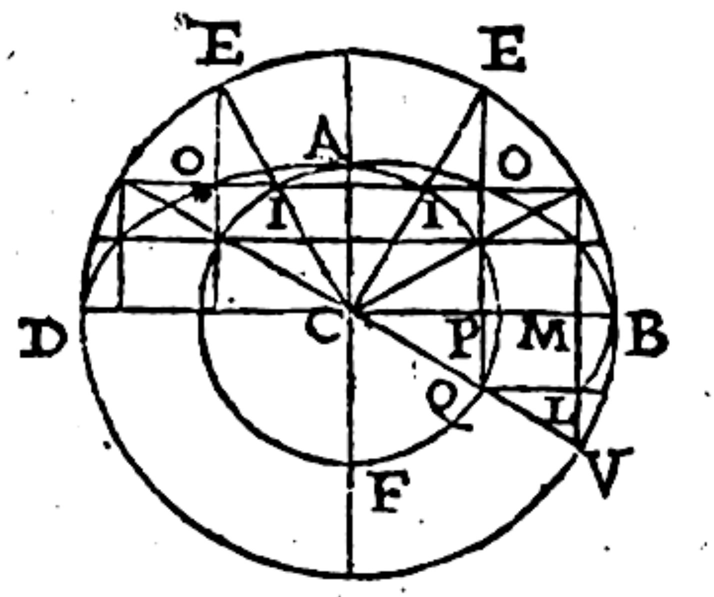
[87] Ibid., 391.
[88] Ibid.
[89] Ibid., 406.

triangular vertices that are subsected at various tangents. It is this level of geometric intricacy that influences Guarini's architectural design—not only in terms of the solid structures that constitute the building itself, but the way in which the light of the sun interacts within the space.

The geometric function described by way of the ellipse incurs the interaction between concentric or parallel rings (*maximus circulis parallelis*) which make contact with the sphere and are inclined at varying degrees (*diversam continuè tangentium esse inclinationem*) according to their subtense (*portiones diametri subtensae arcubus aequalibus, quò propinquiores fiunt alteri diametro in quadrante, eò sunt maiores*).[90]



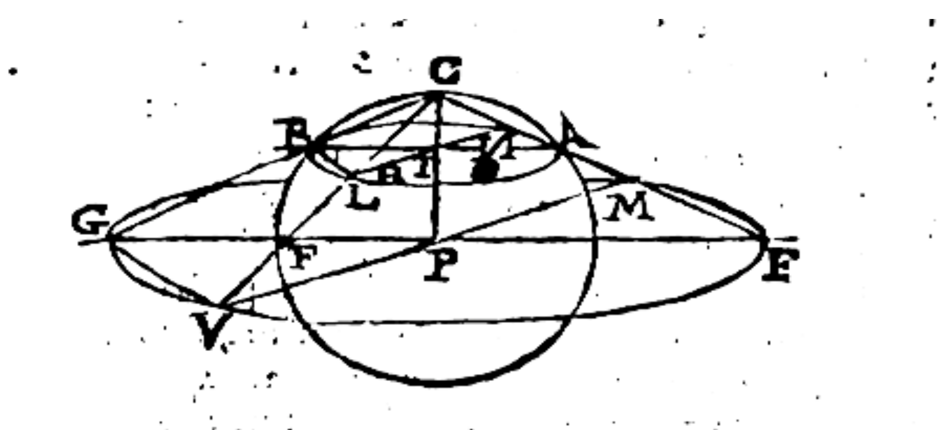
32.
Diagram of an Ellipse, Guarini, *Euclides Adauctus*, pg. 429

[90] Ibid., 381, 382.

The elliptical forms created by the interaction between sphere and focal point are applied in the building of the dome above the sanctuary space. The oval shape as well as the six-sided Seal of Solomon created by interlacing vertices is demonstrated with this geometrical form from the *Euclides*.

The asymptote is important in relation to gnomonics and horology in Guarini's theory of architecture which he applies to the parabolic design within the catenary curves of San Lorenzo's dome to express the movement of the sun. Both of these sciences are related to the analysis of quadrangles and parametrics according to the movement of the earth around the sun that allow the measurement of the sun by casting a shadow.

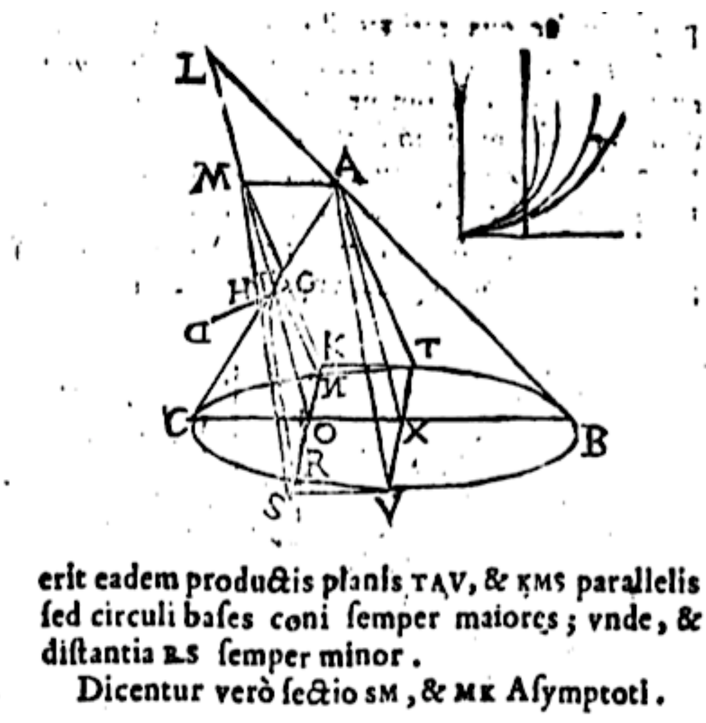
Guarini demonstrates that an ellipsoidal section is created by drawing a chord across the base of the parabola and extending rectilinear angles upward (*rectangulorum altitudines*), where they meet at a point upon the vertical surface of the cone.[91]



33.
Gnomonics pertaining to a sphere,
Guarini, *Euclides Adauctus*, pg. 455

[91] Ibid., 393.

The concentric rotation of the indivisible point and its diagonal extensions form the model of a hyperbola and as the indivisble point rotates, it forms an asymptote, a concentric spiral that tends toward infinity (*quòd hyperbole semper ad asymptotos accedit*).[92] The finitude of the indivisible point is expanded to infinite (or near infinite) quantity through the model of the hyperbola (*puncta finita in infinitum in quantitate*).[93] Hyperbolic geometry is elaborated further in Guarini's theory of conics (*Tractatus XXIV* and *XXV*).



34.
Section of a parallelogram through a conic form,
Guarini, *Euclides*, pg. 417

[92] Ibid., 5.
[93] Ibid.

Guarini states the rotation of this infinite spiral is applicable to the universal laws of physics, stating that God creates the elements of the universe from the rotation of this infinite spiral. The rotational axis is expressed by declination and degree, as in the measurement of a clock or the movement of the shadow cast by the gnomon on the surface of a sundial.

Indivisible mathematics is based on point, line and surface, while still considering the importance of geospatial coordinates such as latitude and longitude. Point is synonymous with the concept of location (*loco*); line is synonymous with the *axis mundi* and longitude; surface is synonymous with latitude as indivisible space extends and approaches infinity (*punctum, cuius pars nulla, linea, quae partes habet secundùm longitudinem tantùm. Superficies, quae partes obtinet secundùm longitudinem, & latitudinem*).[94]

As in classical mechanics the rotation of the indivisible point creates mass (*molis*), as the surfaces which surround the point are not tangential, but penetrate the center within it, expanding the point (*si superficies partes enumaret, illa non effet ultimum molis; nec proprie tangeretur; sed penetraretur: cum illud, quod tangeretur, non effet exterius; sed quid internum*).[95]

The theory of indivisible space concludes by discussing the relationship of isoperimetric planes and corporeal bodies (*planities, & à planis ad corpora*) extending forth at

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[94] Ibid., 9.

[95] Ibid., 10.; Isaac Newton, *Philosophiæ Naturalis Principia Mathematica* (Londini: Josephi Streater, 1687), 35. Newton's *Principia* begins to describe the relationship between quantity and indivisibility, the interpenetration of the indivisible point, and between mass and the contiguity of expansion. "*Obiecto est, quod quantitatum evanescentium nulla sit ultima proportio; quippe quæ, antequam evanuerunt, non est ultima, ubi evanerunt, nulla est. Sed & eodem argumento æque contendi posset nullam esse corporis ad certum locum pergentis velocitatem ultimam. Hanc enim, antequam corpus attingit locum, non esse ultimam, ubi attigit, nullam esse. Et responsio facilis est. Per velocitatem ultimam intelligi eam, qua corpus movetur neq; antequam attingit locum ultimum & motus cessat, neq; postea, sed tum cum attingit, id est illam ipsam velocitatem quacum corpus attingit locum ultimum & motus cessat.*"

every conceivable rectilinear angle (*omnibus angulis rectis*).[96] *Tractatus I* of the *Euclides* sets forth a foundation for Guarini's intricate demonstration of the mathematical relationship between physics (*macchinaria*) and spatial dimension (*gnomonica*) that is directly applicable to architecture (*edifizio*) and to the Church of San Lorenzo.

Tractatus IX, Pars Prima pertains to the fifth book of the *Elements* (*In Librum V Euclidis*) and to the idea of proportion (*De Proportionum Notione*). *Expensio I*, on calculation (*Quid sit Ratio*), states that calculation involves the relationship of quantities. Calculation, therefore, is the relationship of parts to the whole, of everything which exists as proportionate, that is beyond the function of its prior origin, and its total and proven definition (*cum ergo ratio en relatione partis, & totius consistat, & commensurationis, & operae praetium est priùs partis, & totius definitionem declarare*).[97]

The third clause in the definition (*operae praetium est priùs partis*) is the functional quality of a lemma, based on the precognitive knowledge of a definition which allows the geometrical expansion of the idea through the expansion of proportion. This procedure is based on Guarini's next definition, which examines proportion through minor and major magnitude, in which doubling changes parts from few to multitudinous (*duplex ex pars alia Aliquota, alia Aliquanta*).

Guarini states that there is no finite proportion which corresponds with the infinite (*ergo finitum infinito nulla proportione conformatur*); therefore, infinity and that which pertains to the infinite is not a proportion (*infiniti ad infinitum nulla est proportio*).[98] One cannot create a greater sum of infinity, but the idea of the infinite may be increased and

[96] Guarini, *Euclides*, 12.
[97] Ibid., 106.
[98] Ibid., 108.

augmented (*ergo infinitum non potest habere aliud infinitum maius & iedo multiplicatum erit*).[99]

The replication of proportion for composition is made greater according to the magnitude of three, so that it is the first and the middle calculation. As the middle is according to thirds, and thirds to fourths, the first will correctly duplicate the proportion of three, by tripling and quadrupling consecutively until the appearance of the limit (*proportio replicata est; cum trium maginitudinum, vel plurium, eadem est ratio prima ad mediam, quae media ad tertiam, & tertiae ad quarta primae enim dicitur duplicata habere proportionem ad tertiam; triplicatam ad quartam, & sic consequtivè donec termini extiterint*).[100]

Proportion and quantification change and multiply, while their calculation remains similitudinous (*proportionibus dissimilitudinem, & tandem de plurium quantitatum ad plures in rationibus similitudine*).[101] This method of proportional calculation is important from an architectural vantagepoint, because the method of calculation or *ratio* is a core or axis, a fulcrum around which multiplicity and magnitude are formed. The *ratio* of 1:3 or 1:5 is equivalent, however, delineated by numeration and division. This formation may be antecedent or consequential; however, the importance of this form of proportion is that the method of calculation pertains to magnitude, and not static or quantitative distance, creating a sense of infinite or 'ecclesiastical' space within the work of architecture.[102]

Tractatus X pertains to Book Six of the *Elements* and the proportion of continuous quantity (*de proportionibus quantitatis continuae*). The generation of proportion descends

[99] Ibid.
[100] Ibid., 111.
[101] Ibid.
[102] Ibid., 126. "*Si sint magnitudines quotcumque proportionales; quemadmodum se habuerit una antecendentium ad unam concqequentium; ita se habebunt omnes antecedentes ad omnes consequentes.*"

through the diversification of matter, which is particularly useful in numerical calculation and the continuation of quantity.[103] This method of continual quantity develops out of *Tractatus IX*, by delineating between rational and irrational numerical calculation (*quantitatis verò contìnuae duplex est, alia rationalis, alia irrationalis*) and by placing this method of calculation within a framework of geometric forms, such as triangles, parallelograms and their division.[104]

Disputatio IV of the *Placita Philosophica*, On the Location, Distance and Magnitude of the Stars (*De Loco, Distantia, Magnitudineque Stellarum*), discusses what one may gain through the use of mathematics as an instrument of measurement for astronomy (*oportet nos mathematicos profiteri, & iam instrumenta mensoria prae manibus habere, si tamen caelestes affectiones intimiùs perscrutari volumus*).[105] The movement of the stars and their revolution around the celestial sphere pertains to how their rays of light extend forth (*motuum enim illorum volumina, illius lucis extensionem*).[106]

As in Euclid's *Elements*, Guarini states that the point is that which has no part: "Our intellect is inadequate to conceive of the existence of the point, for the reason that it is not simply the end of a line, nor is it the ultimate or penultimate completion of something, for this too would have parts and would be divisible."[107] This definition of the point has been upheld by mathematicians throughout history such as Proclus (*sin ut in infinitum dividi potest, neque partibiles terminos, neque insectiles unquam comprehenderis*), Martianus

[103] Ibid., 132.
[104] Ibid.
[105] Ibid., 307.
[106] Ibid.
[107] Guarini, *Civile* (Tavassi la Greca), 30.; Euclid, *Elements Vol. 1*, 153.

Capella (fl. c. 410–420) (*punctum est cuius nihil est*), and Hermann Bonitz (1814–1888) (*theile giebt es*).[108]

Aristotle provides us with a universal principle which is like a point that has no parts and exists independently from the cohesive structure of matter.[109] This principle relates Proclus' definition of the point containing the potential of the infinite. This potentiality is made finite by its structural connection to the circle in which it resides.[110]

The relationship between conics and spheres is an architectural principle pertaining to the geometry of domes, because of their rotundity and because of the division of conics in the formation of parabolae and hyperbolae. This relationship also exists in the structure of San Lorenzo's dome, in the demarcation of space between the top of the dome and the outside of the drum and from the top of the lantern down to the level of the springing.

In the *Caelestis*, the figure is used to explain how "the transmutation of time is related to the metonymic shifting of days." Time is expressed as a circularity, its transmutation into movement creating a "sumptuous and richly adorned sense of unity."[111] This is expressed mathematically by the movement from one point of perpendicularity across the curvature of the circle (representing the passage of the sun) to another point.

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[108] Proclus, *Insignis philosophi compendaria de motu disputatio, posteriores quinque Aristotelis de Auscoltatione naturali libros, mira brevitate complectens* (Paris: Apud Iocabum Bogardum sub insigni D. Christophori è regione gymnasii Cameracensis, 1542), (unpaginated).
[109] Friedrich Ueberweg, *A History of Philosophy: From Thales to the Present Time*, trans. Geo. S. Morris (London: Hodder and Stoughton, 1872), 158.
[110] Guarini, *Civile* (Tavassi la Greca), 34. "*Il circolo è una figura piana compresa da una linea solamente detta periferia, che comprende e chiude un punto detto centro, a cui le linee da lei condotte sono tutte eguali, come nella figura decimaterza il circolo CID che compreso dalla linea detta periferia, che ha il punto P, da cui tirate le linee PI e PD e PC e simili, sono tutte eguali; onde P sarà il suo centro, per la qual cosa, se vi sarà una figura che sia compresa da una linea solamente e non abbia punto in sé, a cui si tirino le linee uguali, sarà elissi, overo ovato, ma non circolo.*" This passage correlates with Tav. 1, Fig. 13.; Proclus, *A Commentary on the First Book of Euclid's Elements*, trans. Glen R. Morrow (Princeton, NJ: Princeton University Press, 1970), 13.
[111] Guarini, *Caelestis*, 98. "*Haec propositio intendit explicare, quare in transmutione horarum sit necesse sæpe sæpius denominationem dieu mutare, & assumere dies, vel unitate ditiores, vel ea ornatos, sit itaque circulus, qui tempus exprimat…*"

In the *Placita*, the perpendicularity of the circular figure represents the surface of the sun (*corporis luminosi superficie perpendiculariter exit*) which is seen in relation to the rays emitted by the sun which are described as parallel.[112] Guarini diagrammatically connects the parallel rays of the sun to the perpendicularity of the sun's surface, to represent the spherical emanation of the sun's rays in every conceivable direction.

Guarini references Vitruvius once again, in stating the architect's importance as a scholar of the stars and as someone who calculates the knowledge possessed by the sky (*astrologiam, caelique rationes cognitas habeat*).[113] Guarini's description of the magnetic compass correlates with the moveable square (*squadramobile*), so that the level surface of the compass is adjoined with a semicircle. The center of the compass is parallel with the compass and perpendicular to the *squadramobile* (*e polo de Calamita, sia parallela ad un lato, e perpendiocolare all' altro*).[114]

As a model of the *axis mundi*, the circle and its center is a diagram of the universe set in motion, the changing position of the *gnomon* as the earth circumnavigates the sun. San Lorenzo's floorplan is also constructed around the form of the circle as shafts of sun-light penetrate the dome, demarcating the movement of time.

The beginning of *Disputatio XI* explains the difference between surfaces, which are bodies in motion (*corporis ambientis*) and the continuum of matter that circumnavigates a central locus (*dicitur continentis, quia locus adaequatus ex omni parte debet circundare*

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[112] Guarini, *Placita*, 305.
[113] Guarini, *Civile*, 48.
[114] Ibid.

locatum).[115] All distances are connected and fixed to this immovable locus (*omnium distantiam fixam*), this celestial pole which determines the movement of the heavens (*sicut tempus desumitur à motu caeli*).[116]

The celestial sphere is first defined as a cosmographic center point according to its axis, with which Guarini determines latitudinal and longitudinal locations of cities and of building sites such as Austria, Rome, Domo Lauretana and Lugdunum (modern-day Lyon, France).[117] Here, the celestial sphere is used as a spherical astrolabe and in the calculation of terrestrial coordinates according to the position of the stars, by which to determine the proper location of the building site.

However, the cosmographic relationship between the celestial pole and the location of a building is not merely determined by a physical distance that exists between two tangential bodies (*duobus corporibus non se tangentibus*).[118] The celestial pole is defined as an arm which stands apart and is itself a body which does not move (*ulnis destitissent, etiamsi illa corpora nihil mota fuissent*).[119] Delineating between the idea of *locus* and *vacuo*, Guarini explains that while location is defined by the celestial pole, void space is thus illusory (*tanquam in loco aliquo reali, in spatiis imaginariis*).[120]

The potential of lines extends to the use of triangular divisions to allow the connection between two rectangles at various declinations (*De potentiâ laterum triangulorum*). When a line is extended from the middle of a rectangle that is parallel with its side and lines are drawn to meet it at a point, this forms a triangle, from which may generate two

[115] Ibid., 274.
[116] Ibid.
[117] Ibid.
[118] Guarini, *Placita*, 274.
[119] Ibid.
[120] Ibid., 275.

other rectangles, connected to its vertices (*in triangulis rectangulis quadratum, quod à latere rectum angulum substendente describitur, æquale est duobus quadratis, quæ à lateribus angulum rectum continentibus describintur*).[121] This theorem is expanded, using obtuse (*amblygonijs*) and acute (*oxigono*) triangles as well as the creation of the trapezoid, using a curvilinear extension between the two opposing points of rectangles which are extended from the triangle.[122]

Disputatio V, On the Movement of the Celestial Sphere (*De Motibus Spaerarum Caelestium*), describes the movement of planets and stars around the sphere as a compuational machine (*figuris machinamentisque*), their measurement drawn out by their mass and physical momentum (*computum extrahere, nec planetarij laboris mensuras obtinere possimus*).[123] This definition in *Disputatio V*, of the celestial sphere as a machine, relates directly to time (*orologia*) and to movement (*macchinaria*), the second and third premises of Guarini's theory of architecture.[124]

Disputatio VI, On the Influx of the Heavens (*De Influxibus Caelorum*) describes how the element of time descends onto the celestial sphere and onto the earth as it orbits the sun (*iam tempus est, ut incipiamus descendere, & à caelestibus circulis, ab terrenos orbes deprimi*).[125] Guarini expresses several theories of time and how it relates to the emanation of the sun and the propagation of life on the earth (*nam adveniente sole, videmus*

[121] Ibid., 58.
[122] Ibid., 61.
[123] Ibid., 326.
[124] Ibid., 346. From *Expensio VII: De Tempore Solari*: "*Notandum est igitur, tempus Solare distingui communi hominem voce, in Dies & Annos.*"; Ibid., 353. From *Expensio VIII*: *De Motibus Lunæ*: "*…annis etiam Lunaribus tempus mensurate…*"
[125] Guarini, *Placita*, 367.

omnia florere & germinare).[126] The light of the sun and the movement of the stars, which are seen as both corporeal and magnetic, are part of the influx of time into the universe.

The significance of *De Influxibus* in relation to Guarini's architecture theory exists as a philosophical relationship that is created between light and substantial form. This argument is found in *Expensio VII* (*An astra influant per lucem, tanquam per causam instrumentalem*) and pertains to the design of the structure of the universe (which is finite), according to the influx of light (which is infinite).[127] The perfection, arrangement and finitude of the heavens is predicated upon the visible creation of light, the principal causation of form.

Standing on the floor of San Lorenzo, looking up at the dome, one finds themselves standing below and within the celestial sphere which appears to spin into infinity according to the geometries within the lantern and the catenaries that create the complex facets of the dome. The influx of the universe can be felt when standing within the church, as if San Lorenzo is an astronomical observatory; a telescope in reverse, which draws the universe closer, as opposed to looking outward into the farther reaches of space.

The relationship between the sphere and surface planes leads to the study of parabolic and hyperbolic conoids in which the surface of the cone rotates (*conoides parabolicum parabola circa suum axem volutata formatur, & axis eius est axis etiam parabolae genericus*).[128] The direct relationship that this geometry bears on San Lorenzo and Guarini's studies of gnomonics, quadrangles and parametrics is the apparent spinning motion experienced by the viewer as one looks upward toward the dome.

[126] Ibid., 367. Besides being a philosophical argument, *Expensio VII* deals with the physicality of light as heat (*calefactione*), which is part of the process of creating substantial form from light itself.
[127] Ibid., 372.
[128] Ibid., 440.

This motion is expressed with elegant precision, as a perimetric relationship of rotating planes within a parabola (*nam eius ambitus formabitur à puncto c per motum parabolae circa axem aq…cumque perimetrum parabolae maneat semper invariatrum punctum*).[129] The point, representing the *axis mundi*, is invariant; the perimetric movement, the spinning motion of the conoid, is in cosmographic terms the movement of the celestial sphere around that point as it tends toward the infinity which surrounds it (*sit conoides hyperbolicum tdv, & figurae ex generatione eidem tdv asymptoti sint ba, & ac*).[130]

It is in the perfect equanimity of its movement that the asymptote approaches the infinite (*quibus perfectis erunt omnes aequales*), its planar divisions (*quadratum*) represented by the shadow cast by the gnomon (*gnomone ambiens quadratum*).[131] Guarini studies the effects of light and shadow within parabolic and hyperbolic structures in order to create domes which serve as sundials and spherical astrolabes, such as the dome of San Lorenzo.[132]

Tractatus XXVI of the *Euclides,* pertains to projective geometry (*De Proiecturis*); *Pars Prima* to orthography (*De Orthographia*), and *Pars Secunda* to stereography (*De Stereographia*).[133] Projective geometry serves as an extension of the principles presented in *Tractatus XXV* and *Tractatus XXIV*, in which the principles of gnomonics are connected to horology (*tum horologijs, tum instrumentis mathematicae*), the astrolabe, quadratics and cosmography (*astrolabio, & quadrantibus: tum cosmographiae*). Guarini directly applies

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[129] Ibid.
[130] Ibid., 441.
[131] Ibid.
[132] Gibbs, *Sundials*, 11. The sundial may have led to the definition of conics by Menaechmus in the fourth century B.C. "Certainly a plane sundial with perpendicular gnomon always pointing to the culminating sun embodies the conditions which determine a hyperbola in Menaechmus's theory."
[133] Guarini, *Architettura Civile*, 73, 191. *Trattato III*, *Della Ortografia Elevata*, and *Trattato IV*, *Della Ortografia Gettata* of the *Architettura Civile* are mathematically connected to the orthographic principles presented in *Tractatus XXVI* of the *Euclides*.

these princples to architecture (*maximè architecturae ad proicienda corporum*) and to the planes of extension that are created through the oculus of the building, connecting it to the sun and to the stars (*ocularis prospectus representatur in planum extendere oporteat, & ipsa quoque corpora, superficiesque in planum proicere*).[134]

The passage of light within the church is expressed as the geometries of its physical structure, creating an optical relationship between light and geometry. The relationship betweeen light and mathematics is at the core of Guarini's philosophy of architecture (*quod ea omnia, quæ Mathematicas luces, & euidentias in unicum lucis fontem*).[135] Light is the true substance, to be bound in unity and subjugated into mathematical forms (*Ideoq; cum tota Mathematica, sit alligata in unumq; corpus naturali lege devincta*).[136] The light of the sun is cast into the church; the church is a simulacrum of the light that it casts.

Several theories of shadow projection exist which pertain to the geometric relationship between astronomical bodies and the light or shadow that they cast. In Ptolemy's theory of the *Analemma*, he demonstrates the light cast by a spherical heavenly body on a two-dimensional plane. In Ptolemy's *Planispherum* this method is applied to the construction

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[134] Guarini, *Euclides*, 444.

[135] Guarini. *Euclides*, ("Benevolo Lectori"), unpaginated. "*Cum inter illos, qui in elementa Euclidis desudarunt, nullum intuear, unico concarcinare volumine, quæ ad quantitem sub genere investigandam faciunt, secutus seculi genium, quod centiuriat, ut plurimùm, & florilegia condit, putavi nequaquam me frugem perdere; si huic muneri universaliùs inservirem, & Mathematica rerum exordia ex omni parte rotunda, & contornata exiberem. Siquidem ex meo labore didici, euius pretij, cuius utilitatis id operis emergat ; quod ea omnia, quæ Mathematicas luces, & euidentias in unicum lucis fontem, adeoq, solem ne dum tumultuaria collectione aglomeret ; sed etiam ordinato agmine disponat, in seriesq ; suas naturali consecutione distinguat præcipué illis, qui nullo Mercurio tramitis indice, aut duce audent se huic studio consignare, & admodùm dificilem provinciam in suam sarcinam traducere.*" It is interesting that the mention of Mercury's transmission referenced here within the untranslated part of this quote might in fact pertain to the planet's transit over the sun in 1661. This celestial phenomenon was also observed by the astronomer and contemporary of Guarini, Christiaan Huygens. This celestial phenomenon would have also allowed for certain astronomical observations exemplified in Guarini's *Cælestis*. This reference may also be observed in note 77: Ibid., ("Benevolo Lectori"), in which "Mercury transmits no indexical path…"

[136] Guarini, *Euclides*, ("Benevolo Lectori"). "*Ideoq; cum tota Mathematica, sit alligata in unumq; corpus naturali lege devincta…*"

of a spherical astrolabe.[137] Ptolemy's *Analemma* and *Planispherum* are pertinent to the structure of San Lorenzo's dome and its relationship to the celestial sphere.

Leonardo and Alberti's interest in shadows connect directly to architecture as well as painting. Alberti creates a connection between heavenly bodies and the shadows they cast, stating that "the light of stars makes shadows exactly the same size as bodies…a shadow is made when rays of light are intercepted."[138] Leonardo provides a number of diagrams in his theory of shadows from the *Codex Atlanticus* which resembles the intersecting circles of Brinckmann's ichnographic plan of San Lorenzo.

These theories, connecting astronomical bodies, the projection of shadows and architecture, create a simulacrum of light, its projected shadow and the architectural form. The floorplan of San Lorenzo becomes and inscription of the 'shadow' of the sun, tracing its movement across the sky, like the verticality of the gnomon upon the *subiectum*, casting a shadow upon the horizontal form of the floor.

Tractatus V pertains to the study of parallax (*parallaxes perquisitae*), which is fundamental in the determination of distance between the earth and the planets (*totius astronomia fundamentum meritò censentur, eo quòd per eas distantia Planetarum à terra inveniantur*), eclipses, the discovery of new stars and the approach of comets (*eclipses luminarium, & novorum siderum, cometarumq; cognitionem accedemus*).[139]

The Greeks studied parallax, of which there was a diversion among the Latinists that occurred in the process of translation. This changed the understanding of locus, much like

[137] Thomas Da Costa Kaufmann, "The Perspective of Shadows: The History and Theory of Shadow Projection," *The Journal of the Warburg and Courtauld Institutes* 38 (1975): 263.; Claudii Ptolemaei, *Oprea Astronomica Minora*, ed. J.L. Heiberg (Leipzig: B.G. Teubneri, 1907),
[138] Ibid., 262.
[139] Guarini, *Euclides*, 112.

the opening of the eye upon the surface of an open fret ceiling (*aliam partis laquearis oculis suis abripere*). Guarini connects the structural network of openwork ceilings and domes, to the physiological complexity of the iris as it is reflected upon the curvilinear surface of the cornea to advance the understanding of parallax, creating a syllogistic relationship between architecture, astronomy and the anatomy of the eye.

Of the variant kinds of parallax in respect to the heavens there are eight (*species parallaxis, quae variant respectu caeli sunt octo*), a number which coincides with the octagonal shape of San Lorenzo's lantern, as well as the number of catenaries in the dome.[140]

Of the variant kinds of parallax with respect to the earth, there are three (*species parallaxis respectu terrae sunt tres*); the difference between the planet and how it is observed from one's location and the distance from the center (*eadem distantia à centro*); the difference in location on the surface of the earth (*loco diverso in superficie terrae*) and the conjunction between these two variables allow for the measurement of every kind of parallax (*omnia parallaxim variare possunt*).[141]

The figures which Guarini uses to describe the effect of parallax are hemispherical, with the horizon, *axis mundi* and the ecliptic resembling the catenaries of San Lorenzo's dome, with the earth itself at the position of the center of the dome's drum. These studies, as well as a multitude of others throughout the *Caelestis*, speak to the intricate astronomical considerations that Guarini must have had when designing San Lorenzo.

In observing the conical projection of a shadow cast upon the moon by the earth (*umbra terre sit conica, nempe tanquam pyramis in acumen finiens*), Guarini discusses the

[140] Ibid., 113.
[141] Ibid., 114.

movement of shadow and the dilation of light across its surface (*quiá umbra perambulat, ubi dilata magis est*).[142] Guarini maintains, throughout this disputation, a fascination with the effects of illumination from the sun (*illuminans*) and the reflected light of the moon (*illuminata*), and how the use of *quadratura* can determine the variation of these effects. The use of conics to determine effects of the sun casting a shadow from the earth onto the moon is elaborated further in the *Euclides Adauctus*, connecting to the intricate study of light through fenestrations in the dome of San Lorenzo as well as in the geometries which form the structure of the entire church.

In two dimensions the asymptote is a parabola, but in three it is an infinitely expanding spiral. The use of this geometry, along with the design of the catenary curves and facets of the dome, may cause the viewer looking up at San Lorenzo's dome to sense that it is spinning. Guarini's use of the asymptote is the mathematical explanation of this phenomena. The connection of this phenomena to the movement of the sun, the celestial sphere and to universal dynamics are reserved for the subsequent chapters.

The same diagram of the hyperbola represented here is also shown in the first chapter of *Euclides Adauctus*, *Tractatus I*, *Præliminaris* which presents an illustration of an asymptotic hyperbola.[143] The emphasis on visual rays of light being 'thrown' or 'pulled' (*tirino*) in order to form the hyperbola expresses the function of light as it enters through the curved form of the dome, and that the form of the dome is, in fact, structurally brought

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[142] Guarini, *Placita*, 308.

[143] Guarini, *Euclides*, *Tractatus I*, 5; *Tractatus XXIV*, 429. Asymptotic here refers to a hyperbola whose angle is approaching infinity, and may relate to Guarini's intention to create a sense of infinite space within the *cupola* of San Lorenzo. The asymptote was introduced by Apollonius of Perga in his work on conic sections. For more research on the conics of Apollonius, see, J.P. Hogendijk, *Ibn al-Haytham's Completion of the Conics* (New York: Springer Verlag, 1985), 30–51, 82, 100, 312. Apollonius is also referenced extensively in Guarini's *Euclides* and *Cælestis*. See, Guarini, *Euclides*, ("Benevolo Lectori"), (Apollonius of Perga is referred to here as Pergæi); Guarini, *Cælestis*, 390.

about by its direct interaction with light, creating a form that is synthetic with the element with which it interacts. Guarini defines this as an asymptotic hyperbola due to the interaction or cohesion created by the concurrence between the structure (geometry) and what it is structured by (light). Hyperbolas such as this can also be found in *Tractatus XXIV*, *De Sectionibus Conicis* (On the Conic Section) of *Euclides* as well and Chapter Four, *In Primum Librum Elementorum* also contains extensive diagrams of hyperbolas in various dimensions.[144]

Indivisible mathematics is based on point, line and surface, while still considering the importance of geospatial coordinates such as latitude and longitude. Point is synonymous with the concept of *loco*; line is synonymous with the *axis mundi* and longitude; surface is synonymous with latitude, as indivisible space extends and approaches infinity (*punctum, cuius pars nulla, linea, quae partes habet secundùm longitudinem tantùm. Superficies, quae partes obtinet secundùm longitudinem, & latitudinem*).[145]

The theory of indivisible space concludes by discussing the relationship of isoperimetric planes and corporeal bodies (*planities, & à planis ad corpora*) extending forth at every conceivable rectilinear angle (*omnibus angulis rectis*).[146] *Tractatus I* of the *Euclides* sets forth a foundation for Guarini's intricate demonstration of the mathematical relationship between physics (*macchinaria*) and spatial dimension (*gnomonica*), that is directly applicable to architecture (*edifizio*), and to the Church of San Lorenzo.

The *Preliminares* of *Tractatus II* defines the essence of distinct quanitites (*De eßentia quantitatis discretae*). Guarini states the essence of unified quantity is dependent on a

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[144] Guarini, *Euclides*, 390.; Ibid., 33.
[145] Ibid., 9.
[146] Guarini, *Euclides*, 12.

cognitive understanding of each separate quantity (*dependant à quantitatis discretae cognitione*).[147] The unity of numbers exists in the intellect (*intellectus omnis unitas numeralis*); this foundation upholds their unity as distinct entities and as a unified whole. Each individual number corresponds to every other and posseses the unity of the whole in their individuation (*unitatem individualem possideret*).[148] Unity is the principle of distinct quanitities (*unitas, quae est principium quantitatis discretae*). Each number, according to its foundation (*subiectum*), brings to fruition additional unity, which creates multiplicity through a coincidence with other unified numbers (*accidens superadditú*).[149] *Tractatus II* describes a brief system of logic, which according to Guarini is a simple operation of the intellect (*licet operationes intellectus, ut simpliciter tales, sint ad placitum*) with which to speculate on the nature of mathematics.[150]

Tractatus VI pertains to the third book of the *Elements*, which focuses on the circle, the figure which is the origin of all geometry. The circle is the generative principle of all integral and constructed shapes, including the triangle, square as well as curvilinear lines, which generate the formation of hyperbolae, parabolae, ellipses, spheres and conics.[151] Several demonstrations commence, which all generate from the point at the center of the circle, and how it may be extended in various dimensions to create simulacra of the circle,

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[147] Ibid., 13.
[148] Ibid.
[149] Ibid., 14–15.
[150] Ibid., 20.
[151] Guarini, *Euclid*, 63. "*Egit in duobus primus Libris Euclides de primo genere superficierum; nimirum de rectilineis, & non quidem de omnibus; sed solùm de præcipuis, & quæ alias figuras planas integrant, & componunt, ut sunt triangula, & quadrangula, nimirum, ut eas solùm, quæ erant elementares attingeret: In hoc verò tertio Libro agit de circulis, quæ figura est origo, & principiùm omnium linearum flexarum, puta Hyperbolæ, Parabolæ, Ellipsis, aliarumque similium, ut sicuti rectilineorum Elementa, & flexorum quoque doceat, his enim principijs ferè omnia fundatur, quæ tum de sphera, tum de sectionibus conicis ostendentur.*"

which then extends rectilinearity forth, forming the potentiality of other forms (hyperbolic, parabolic, etc.).

Tractatus VII pertains to Book Four of the *Elements* and to the inscription and circumscription of the circle (*In Librum quartum Elementorum. De inscriptione & circumscriptione figurarum in circulo*). As a progression from *Tractatus VI*, Book Four forms a comparison between the circle and other solid figures, thus developing the figure of the circle into a solid Archimedean sphere.[152] The extension of a line within the figure, a triangle or rectilinear form, multiplies the form of the circle by shifting its axis point. Differently than the previous demonstration, the shifting of the axis connects the two circles which double to form a solid (*insistens erunt duplicia*).[153]

The duplication of geometric forms within the circle is also a reference to Clavius, in which he theorizes on the amount of multilateral, equilateral and equiangular figures that may be repeated within the form of the circle (*reperire figuras multilateras, aequilateras, & equiangulas*).[154] The inside periphery of the circle is divided into fifteen angles (*quindecagoni*), which are divided into the pentagon and the triangle, intersecting at various equidistant arclengths (*probatur tres arcus, quibus anguli trianguli insistunt, vel quibus latera equalia subtenduntur*).[155]

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[152] Ibid., 83. "*Liber quartus agit de descriptione figurarum respectivè ad circulum; licet enim triangula, & quadrata possit sine circulo describi, commodiùs tamen cum reliquis figuris, aut intra circulum, aut circa circulum describuntur. Usus verò huius Libri pernecessarius est, tum solidis in sphæra inscribendis, & circumscribendis, tum ad comparationem externæ figuræ solidæ, cum interna, ex qua Archimedes soliditatem sphæræ adivenit, tum ad lineas, chordasque arcuum inveniendas, & tandem ad Militares delinationes fortalitorum.*" Noted at the end of the previous not, reference to Archimedes pertains to the use of spherical geometry for military fortification, connecting Guarini's Euclidean knowledge to that of the *Trattato di Fortificatione*.; Ibid. "*Antequam propositiones ipsas aggrediamur aliqua principia, definitionesque ad hunc librum, spetialiter spectantes oportet agnoscere; istæ verò sunt.*"
[153] Ibid., 87.
[154] Ibid., 91.
[155] Ibid.

Tractatus XIII, *Pars Tertia*, involves the circularity of the sphere and the circular planes that may intersect it (*De maximorum circulorum in sphaera, minorumque intersectionibus, contactibusque mutuis*).[156] The geometries in *Pars Tertia* maintain the greatest significance when applied to the astronomy presented in the *Caelestis* and in their direct application to Guarini's architecture, most notably in the design of San Lorenzo's dome as well as the dome above the sanctuary and its peripheral geometries.

This geometric function lies in the interaction between concentric or parallel rings (*maximus circulis parallelis*), which make contact with the sphere and are inclined at varying degrees (*diversam continuè tangentium esse inclinationem*) according to their subtense (*portiones diametri subtensae arcubus aequalibus, quò propinquiores fiunt alteri diametro in quadrante, eò sunt maiores*).[157]

The distinction is made between the geometry of the parabola, which ends at the point of its axis (*planum secant parallelum uni lateri sectionis per axem adigitur*), and a hyperbola, the planes of which continue through the axis point, creating vertices which face the opposite direction (*planum secet utrunque conum ad verticem erunt opposite figurae*).[158]

Guarini demonstrates that an ellipsoidal section is created by drawing a chord across the base of the parabola (*quadrate segmentis chordae*) and extending rectilinear angles upward (*rectangulorum altitudines*), where they meet at a point upon the vertical

[156] Ibid., 373.
[157] Ibid., 381, 382.
[158] Ibid., 391.

surface of the cone.[159] The significance of the ellipse is evident in the design of San Lorenzo in the formation of catenary curves that constitute the central dome as well as the perimeter of the space above the sanctuary.

Guarini describes the position and function of the *umbelicus*, in which the curved surfaces of a hyperbola are equal to one another (*umbelicus est quoddam punctum intra sectionem, quod insignes proprietates obtinet, maximè ad ipsarem sectionem*).[160] Guarini creates a parametric set of equations (*parametrum*) that describes the formation of ellipses caused by the binary movement of two points (*focos*). The variation between parabola and hyperbola can be taken between two different measurements, from the interior surface to the exterior.

The interaction between hyperbola and ellipse provides a description of an intricate geometry of triangular vertices that are subsected at various tangents. It is this level of geometric intricacy that influences Guarini's architectural design—not only in terms of the solid structures that constitute the building itself, but the way in which the light of the sun interacts within the space.

Guarini's analysis of conics is exquisite, providing a spatial understanding of the geometries connected to the parabola and hyperbola but also connecting them to the theory of gnomonics (*gnomonem*), represented by quadrangles (*quadratum*) that extend from the *umbelicus*. Guarini applies the term *permutando*, emphasizing the transformational nature of light in relation to movement in his system of geometry, which leads to a careful analysis of the asymptote (*de asymptoto hyperbolarum proprietate*).[161]

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[159] Ibid., 393.
[160] Ibid., 406.
[161] Ibid., 416.

Guarini describes the asymptote as two tangential planes within the hyperbolic cone that move beyond its perimeters (*extra conum extenso efficiunt*) and the potential of mathematical comprehension (*inutilis contemplatio*).[162] The asymptote is important in relation to gnomonics and horology in Guarini's theory of architecture, which he applies to the design of San Lorenzo's dome.

While gnomonics and horology are related to the analysis of quadrangles and parametrics, Guarini states that the infinite nature of the asymptote is created by the expansion of the singular point (*datus eius asymptotis, & unico eius puncto*). Guarini describes the formation of an ellipse predicated upon the expansion of this unified point that is described by a diagram which also appears in the *Civile*, as well as in Book Six of the *Elements*. The diagram applies to the structure of the sanctuary space of San Lorenzo, the expansion of the center point to the sanctuary dome.

In observing the conical projection of a shadow cast upon the moon by the earth (*umbra terre sit conica, nempe tanquam pyramis in acumen finiens*), Guarini discusses the movement of shadow and the dilation of light across its surface (*quiá umbra perambulat, ubi dilata magis est*).[163] Guarini maintains throughout this disputation a fascination with the effects of illumination from the sun (*illuminans*) and the reflected light of the moon (*illuminata*) and how the use of *quadratura* can determine the variation of these effects. The use of conics to determine effects of the sun casting a shadow from the earth onto the moon is elaborated further in the *Euclides Adauctus*, connecting to the intricate study of light through fenestrations in the dome of San Lorenzo as well as in the geometries which form the structure of the entire church.

[162] Ibid.
[163] Guarini, *Placita*, 308.

It is in the perfect equanimity of its movement that the asymptote approaches the infinite (*quibus perfectis erunt omnes aequales*), its planar divisions (*quadratum*) represented by the shadow cast by the gnomon (*gnomone ambiens quadratum*).[164] Guarini studies the effects of light and shadow within parabolic and hyperbolic structures in order to create domes which serve as sundials and spherical astrolabes, such as the dome of San Lorenzo.[165]

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[164] Ibid.

[165] Gibbs, *Sundials*, 11. The sundial may have led to the definition of conics by Menaechmus in the fourth century B.C. "Certainly a plane sundial with perpendicular gnomon always pointing to the culminating sun embodies the conditions which determine a hyperbola in Menaechmus's theory."

Geodesy (*della Geodesia*)

La Chiesa di San Lorenzo expresses a design of the universe put into elegant motion. The *Architettura Civile* is a pragmatic treatise, intended to be applied directly to the construction of such an artifice. The principles in theory are manifestations, ideas of this brilliant design. Following the course of the *Civile*, the *Geometry of the Sun* has moved through four and now onto the fifth dimension of civil architecture.

Book Five (*della Geodesia*) pertains to how San Lorenzo connects to the geometry of the earth, to the sun and to the celestial sphere, and how the geometries at San Lorenzo transform through this intricate spatial interconnection. Looking up at the elegant complexity of San Lorenzo's dome, its complex geometries are not simply symbolic of a living universe, but we may also experience ourselves spinning, like a Sufi mystic spinning into infinity.

Guarini's idea of geodesy moves beyond what he sets up at the beginning of his career in the *Placita*, which is the understanding of the limit. All geometric calculations are intended to move beyond this limit, connecting with one another in symmetry and allowing San Lorenzo to connect with the universe around it, like the dissolving ceiling of the modern-day planetarium as the lights go down and the stars go up.

> In this true institution in which we serve, the itinerant gyration of the heavens does not leave us without its own compendium of concise calculation: it is in fact astronomy which we leave behind, a power which had caused much preoccupation, can in fact greatly attack those true lines and paths which bend, and in our circumnavigation hastily bring forth calculation and

> make obeisance to mechanistic figures, urgent yet temporal reason and other exhortations as an afterthought.[166]

Architecture is an art form almost wholly dependent on mathematics. Time presents itself on the surface of stone in building in a manner that appears ornamental. However, the origin of time presented as architectural ornament is also mathematical, demarcating the presence of time within San Lorenzo as the planet moves around the sun, creating the movement of light within the church throughout the day. The Baroque is presented in sumptuous and elegant glory, so as not to "offend the senses" with the austerity of mathematical precision. It is an elegance seemingly presented upon the surface, but intended to deepen the sensual, sensorial experience within architectural space. The elegant tendrils and volutes seduce the eye to go deeper beneath the surface, so that we are moved by the presence of time within the eternity of light which is the sun.

Within the sumptuous volution and rocaille of the baroque, there is mathematics. Within the celestial sphere, volution relates to spherical movement, while the rocaille and dentils along the drum of the dome appear as points of calculation, demarcating time within the movement of the celestial sphere.

It is in this manner that art, which gives the appearance of sumptuous ornamentation, is at the service of architecture, and that architecture is at the service of mathematics. The rules (*regolæ*) which define this method of building, of which they are five, constitute

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[166] Guarini, *Placita*, 326. "*Illud verò istitutum servabimus, ut gyros itinerum cælestium non disponamum ad eorum calculum breviori compendio vel proniori compendu inveniendum: id enim Astronomis relinquimus, ut pote quæ fuerit præcipua causa, cur in aliquibus tantopere à rectos vertitatis tramite deflexerint, & dum illas ambages calculo subigere currant, & imaginationi adulari figuris mechanimametisque, urgentes interim rationes, aliud suadentes, post habuerint.*"

the first four books of the *Civile*. Book Five is where these figures and calculations are no longer static measurements, they move and transform into the infinite.

The relationship between the sphere and surface planes leads to the study of parabolic and hyperbolic conoids, in which the surface of the conoid turns and rotates (*conoides parabolicum parabola circa suum axem volutata formatur, & axis eius est axis etiam parabolae genericus*).[167] The direct relationship that this geometry bears on San Lorenzo and Guarini's studies of gnomonics, quadrangles and parametrics is the apparent spinning motion experienced by the viewer as one looks upward toward the dome.

This motion is expressed with elegant precision, as a perimetric relationship of rotating planes within a parabola (*nam eius ambitus formabitur à puncto c per motum parabolae circa axem aq…cumque perimetrum parabolae maneat semper invariatrum punctum*).[168] The point, representing the *axis mundi*, is invariant; the perimetric movement, the spinning motion of the conoid, is, in cosmographic terms, the movement of the celestial sphere around that point as it tends toward the infinity which surrounds it (*sit conoides hyperbolicum tdv, & figurae ex generatione eidem tdv asymptoti sint ba, & ac*).[169]

It is in the perfect equanimity of its movement that the asymptote approaches the infinite (*quibus perfectis erunt omnes aequales*), its planar divisions (*quadratum*) represented by the shadow cast by the gnomon (*gnomone ambiens quadratum*).[170] Guarini studies the effects of light and shadow within parabolic and hyperbolic structures in order to

[167] Ibid., 440.
[168] Ibid.
[169] Ibid., 441.
[170] Ibid.

create domes which serve as sundials and spherical astrolabes, such as the dome of San Lorenzo.[171]

A deliberation on the form of universal composition in Book Three of the *Placita*, On Heaven and Earth (*Libros de Caelo et Mundo*), relates the spatial structure of the sphere to temporality, describing perpendicular lines which all fall to the center of the sphere (*Linea perpendiculariter super illorum plana insistens, cadit semper in centrum sphaerae*) that are then divided into three-hundred-and-sixty parts, then into quadrants and ninety degrees, and divided again into sixty parts to describe the minutes and hours created by the movement of planets around the sun at the center of the sphere (*quî magis spherae centro approximat: illi minores, qui magis removentur*).[172]

A deeper reading of the *Placita* reveals an interest in the theory of time, which influences the architect's desire to create a church which dissolves into the light of the sun, into the night and into the infinite. *Disputatio X* of the *Placita* pertains to infinity (*De infinito*), establishing the position that a continuum of endless points is therefore infinite (*quoniam nonnulli dixere quantitatem ex infinitis punctis constare; ideo de ipso hîc infinito agendum est*).

This position on the nature of infinity brings forth an important question of light (*praecedenti quaestioni lucem affermus*). Guarini states that time and eternity are subservient to light itself; even infinity itself may not enter it and is subjected to it. Light exists

[171] Gibbs, *Sundials*, 11. The sundial may have led to the definition of conics by Menaechmus in the fourth century B.C. "Certainly a plane sundial with perpendicular gnomon always pointing to the culminating sun embodies the conditions which determine a hyperbola in Menaechmus's theory."
[172] Guarini, *Placita*, 288.

as that which is beyond the infinite (*etiam quae diximus de tempore & aeternitate subserviemus: cùm ibi non semel, infinitum non posse admitti, supposuerimus*).[155]

Infinity is defined as a philosophical union of the senses, according to all natural possibilty in the mind of the individual (*infinitate individuorum*). Theologically, infinity pertains to the omnipotence of God, and the ability to create all things possible (*totus Deus: ergo & de creaturis possibilibus*).[156]

[155] Ibid., 267.

EPILOGUE

Guarino Guarini designed San Lorenzo to chart the passage of light around the dome of the church according to the diurnal rotation of the earth on its axis, its obliquity and its annular orbit around the sun. Light as being (*ente*) is structured according to the geometric facets of the universe of which the church is a representation. As the earth spins on its axis and revolves around the sun, the dome aligns with the movement of the heavens. The architectural language of the church aligns with the light of the sun, to create a mimesis of the universe.

A dynamic process involving sunlight is made evident in the correlation of geometrical structures in Guarini's San Lorenzo as well as through correlations made with sidereal light and the movement of heavenly bodies represented within Guarini's *Cœlestis*. This system of dynamic interaction between light and geometry within San Lorenzo represents a planetary model, with the sun at the center as the worship space surrounded by the cyclical movement of the planets or the elliptical orbit of planetary bodies, which are also represented by structures in the church.

After thousands of pages of writing and geometric calculation, Guarini comes to the conclusion that the process of the infinite is invariable and meant to go beyond its own system of logical reasoning. The deeper reading of Guarini's treatises leads to theories of mathematics, time, astronomy and architecture as something seated deep within the study of the soul. The connection between the soul and light is the eye and its connection to the brain through the optic nerve—the mysterious place in which the presence and image of the world is experienced—the place that Leonardo da Vinci called the seat of the soul. It is the living membrane between knowing and looking at what we know, between seeing and feeling, between experiencing and non-existence.

Therefore, the focus in creating a summary of Guarini's passage of life through the creation of so many literary and architectural works needs to connect his fascination of light with the eye and what he begins with at the beginning of his writing in the *Placita* by defining the soul. "On the Soul in Communion" (*De Anima in Communi*) argues against Aristotle's theory that the soul is physical, existing within the organization and teleology of nature, stating instead that the body is physical and designed according to nature, but is therefore not a suitable material for the soul (*cadaver est materia physica, & organizata: & tamen non est apta materia anime: ergo*).[1] Rephrasing Aristotle's *De Anima*, in which he defines the potential of the existence as life (*potentiâ vitam habentis*), Guarini states that it is life itself that is the potentiality of existence (*vitam potentiá habentis*).[2]

Disputatio VII, On the Senses of the Soul (*De Anima Sensitiva*), discusses whether the senses of the soul are indivisible (*sit indivisibilis*) or if they exist as one (*omnis anima sensitiva*).[3] The soul is the perfection of the living creature, its potential is evident in the organization of its body (*animae etiam animalium perfectorium, potentiae quaedam sunt in materia organizata*).[4]

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[1] Guarini, *Placita*, 628.
[2] Ibid.
[3] Ibid., 701.
[4] Ibid., 702.

Disputatio VIII, On the External Senses (*De Sensibus Externis*), begins with *Expensio I*: On the Eyes as the Miracle of Architecture (*De Oculi Mirabili Architectura*), directly connecting the optical principles spoken of in *Disputatio VII*, with the art of building. He begins by defining the eight parts which constitute the anatomy of the eye: muscles (*musculis*), membranes (*membranis*), fluids (*humoribus*), nerves (*nervos*), arteries (*arterias*), veins (*venas*), flesh (*carnem*) and corpulence (*adipem*).[5]

This argument leads to an explanation of whether or not the vision of the eye is material or sensorial. The unity of the soul is light as it enters through the organ of the eye (*oculos*). The determination is made between a formal or visual image, dependent on the transparency perceived through the lens of the eye and the crystalline humor (*diaphaneitas, & lens, qualis figurae est humor chrystallinus*).[6] A very careful and detailed explication on the anatomy of the eye, and how it perceives light, exists in *Disputatio VII*, in a manner that differs from Book Four, *De Luce*. Object (*obiectum*) and perception (*perciperet*) are intricately related to the organ of the eye and to the body's orientation within space (*solis, per foramen, in locum obscurum ingrediens videtur*) and its affectation to the color of light (*lux colorata admittur oculum*).[7]

[5] Guarini, *Placita*, 711.
[6] Ibid., 703.
[7] Ibid., 704.

Guarini creates a connection between the anatomy of the human eye and the formation of the interiority and exteriority of architecture according to rotundity, height, *epicanthus* (asymptote) and time.[8] The architecture of the eye (interiority), reflects the architecture of building (exteriority). The eyes are the totality of the building's structure (*haec est oculi totius fabrica*).[9]

His studies of the optic nerve and its connection to the brain, the spine and the anatomy of the body are echoed in the intricacy of his architectural designs. The complexity of San Lorenzo's dome reflects Guarini's knowledge of optics and physiology. A complex understanding of the anatomy and physiology of the eye and the brain creates a tangible understanding of how the intricacies of optical perception occur. The relationship of San Lorenzo to the sun is fortified by Guarini's understanding of optical anatomy as the instrument of vision with which the light of the sun is perceived.

The architect's knowledge of the soul speaks to his relationship to architecture, as once again the focus is on unity and multiplicity and above all, to the light of the sun which is compared to the emanation of the soul within the body (*quare illum accidens coproreum erit, quod aut à causa corporea emanat*).[10] It is an ontological question of existence which is placed upon the experience of the individual within the church (*edifizio*) as a vessel of illumination to commune with the sun (*orologia*) and its movement (*macchinaria*). Time and eternity are subservient to light; light exists beyond the infinite, connecting the soul to God, with the church as its terrestrial instrument.[11]

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[8] Ibid., 711. "*Partes exteriores ita humanum oculum, omniumque quadrupedum obtegunt, ut quamvis rotundi eos tamen in latum discooperiant magis, quàm secundum altitudinem: unde duo oculi Canthi, interior, maior ad nasum, rotundusque; exterior, minor & acutior ad tempora, efformantur.*"

[9] Ibid., 713.

[10] Ibid., 618.

[11] Ibid., 267.

The study of optics is the description (or inscription) of the behavior of light according to geometric principles spatially extended from mathematical coordinates. Guarini establishes an architecture based on light as first principle—a theory of optics applied to architectural form. As Vitruvius states "by means of optics, [*sic*] the light in buildings can be drawn from fixed quarters of the sky."[12] For Guarini light is the *materia prima* which is bound to mathematics, which is subjugated by it to form a unity between light and geometry in the formulation of substance and matter.

He describes the layer underneath the choroid, where the optic nerve exists that brings forth a network of veins upon the black surface of the pupil, connected to the crystalline humor which is, therefore, connected to the cornea, giving form to the diverse colors of the iris. He depicts the pupil as a structure effected by a spinning motion, like the torque created by the earth spinning on its axis (*circa eam velut iridem in ambitum torquet*). The pigmented layer of the eye (*uvea*) that lies underneath the cornea appears to rotate, creating variation of color within the pupil (*sit ut subtus corneam apparet in gyrum uvea; quae cum pupillam, nempe foramen in medio habeat…iris vocatur, propter varietatem colorem pupillam ambientium*).[13]

The intricacies of optical perception within space directly connect the eye as the instrument of vision to the machine (*macchinaria*) that is the movement of light (*orologia*, *gnomonica*) within the Church of San Lorenzo (*edifizio*). When looking up toward the interior of the dome, another aesthetic comparison may be made other than that of the celestial sphere; a simulacrum of the eye—an oculus, the octagonal lantern representing the pupil, the interlaced catenaries and geometric fenestrations in the shape of lunettes and

[12] Smith, *Vitruvius*, 60.
[13] Guarini, *Placita*, 712.

pentagons, representing the colorful pigmented layer below the uvea (*iris vocatur, propter varietatem colorum pupillam ambientium*).[14]

An extension of Guarini's theory of light in *De Luce* pertains to spectrum and refraction according to prisms and spheres. The intricate surface or falling water composed of particles of mist, creates spectral radiance upon the surface of the eye against the darkness of shadow (*in iride, impediret etiam ne pluvia ante oculos tuos positae radios solis vivaces, cùm umbram causaret*).[15] The direct light of the sun is not the source of spectral irridescence; an inversion of color creates the rainbow (*nam radii directi ab ipso sole esse non possunt: tum quia secunda iris inversus coloribus apparet*), caused by particles of water expanding into spheres of aquaeous reflectivity (*istaeque guttulae radios non coloratos in alios superstantes globulos aquaeos reflectant*).[16]

Variations of luminous color are created through the multidirectional refraction of light created in the space between exterior and interior, relating to the convexity of the eye's exterior, and the concavity of its interior (*exterius convexum, interius concavum*), causing the furthest of surfaces to appear within the eye's innermost anatomical structure (*superficies extima intimaque*).[17]

The complex interlacing of geometries and *muqarnesque* patterning in the *cupolino* create a spinning effect, like the rotation of stars around the *axis mundi*, pointing to the zenith. The dome of San Lorenzo, resembling Guarini's anatomical description of an eye,

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[14] Ibid., 712.
[15] Ibid., 496.
[16] Ibid., 497.
[17] Ibid., 716.

is a mirroring instrument of the universe, increasing the depth of one's gaze as a lens of the soul.[18]

[18] Hendrix, *Robert Grosseteste*, 157.; John Hendrix, *The Relation Between Architectural Forms and Philosophical Structures in the Work of Francesco Borromini in Seventeenth-Century Rome* (Lewiston, Queenston, Lampeter: The Edwin Mellen Press*, 2002*), 46.; Noé Badillo, "Ocularium Lucis: Light and Optical Theory in Guarino Guarini's Church of San Lorenzo (MA Thesis: The University of Arizona, 2012), 81.

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APPENDIX I

SUMMARY OF THE TREATISES

What I present here is a brief chronology of Guarini's treatises, a history of their publication and a summary of their content. Guarini's treatises on architecture, mathematics, astronomy, and philosophy, present an all-encompassing, universal science, as it was known in the seventeenth century. Not because they are a key to evidential knowledge as a whole; nor is the aim of Guarini's treatises like the contemporary notion of a "theory of everything." But this universality is revealed in the design of his architecture—universal principles, presented as complex geometries guiding the creation of a series of buildings that reflect the beauty and harmony that is so intricately composed in his writings—the most relevant to our purpose being San Lorenzo.

Nine of Guarini's ten treatises were published between 1665 and 1683; all but the *Architettura Civile*, which was published posthumously in 1737. His treatises on architecture (*Modo di Misurare le Fabbriche*; *Trattato di Fortificatione*; *Architettura Civile*) are published in the vernacular, while his scientific treatises, except for the *Compendio della Sfera Celeste*, are published in Latin. The decision to publish in the vernacular, as opposed to Latin, was probably based on audience and the facility of each language in how it best serves the subject of the treatises.

Guarini published the *Placita Philosophica* (A Philosophical System) in 1665, the *Euclides Adauctus* (The Advancement of Euclid) in 1671, followed by the *Modo di Misurare le Fabbriche* (Methods of Measurement for Building) in 1674, the *Compendio della Sfera Celeste* (Compendium of the Celestial Sphere) in 1675, the *Trattato di Fortificatione* (Treatise on Fortification) in 1676, the *Leges Temporum et Planetarum* (The Laws of Time and the Planets) in 1678, and the *Caelestis Mathematicae* (Celestial Mathematics) in 1683.[1] This massive literary undertaking took place in a mere eighteen years, during a time in which Guarini also completed the design and construction of eleven buildings and laid the groundwork of several other commissions that remain unrealized.

His intellectual rigor can be read in the elegance of his mathematical demonstrations and in the intricacy of astronomical calculations; the physical brunt of this rigorous inquiry is seen in such lofty works of brick, mortar, stone and glass as the Sindone Chapel, Santa Maria d'Aracoeli and San Lorenzo. Guarini's erudition on the subject of mathematics, astronomy and philosophy are a direct influence on the didactic purpose and function of the design of his architecture, and this is most clearly evident upon a close examination of his treatises.

[1] The publication date of Guarini's treatises are verified by the following sources: Francesco Giacomo Tricomi, "Guarini Matematico" in *Guarino Guarini e l'Internazionalità del Barocco* (Torino: Accademia delle Scienze, 1970), 552.

APPENDIX II

LA PIETÀ TRIONFANTE

La Pietà Trionfante (The Triumph of Mercy), was published in Messina in 1660 by Giacomo Mattei. It is dedicated to the Virgin Mary (*la serennisima di Modona*) and begins with a dedicatory ode in her honor.

The publication is a script of a play, a 'tragicommedia' with the intention of the author (*tragicommedia alla luce contra l'intentione dell' autore*). Note that 'contra,' here differs in Italian than what may be assumed to mean 'against,' and means instead "with or without them," rather than 'opposto' which means against.

The play begins with King Clodoardo of Danimarca's fiance being kidnapped by Enchirione, who is the king's first cousin who is also the sister of Iildegarde. Tragedy ensues because of a hurricane, and everyone becomes separated. The triumph of the play is that the hurricane is in the end to blame for the kidnapping and finally the family of the kidnapped fiance is baptized and everything is once again at peace.

APPENDIX III

PLACITA PHILOSPHICA

Placita Philosophica (A Philosophical System), was published in Paris by Dionysian Thierry in 1665, one year prior to Guarini's return to Turin. It was most likely written during the consruction of Sainte-Anne-la-Royale. However, the treatise's dedication to Francisco de Mello et de Torres (1610–1677), Count of Ponte de Lima, Portugal, signifies Guarini's connection to Portugal in relation to politics and patronage and associates the *Placita* to the commission and building of Santa Maria della Divina Providenca in Lisbon. Torres was a commendator, a cleric who owned a fiefdom of several churches from which he, as a diocesan priest, received income.[2]

Guarini begins the dedication to Torres by commenting on the propensive magnanimity of their association, in the zealousness of his mind, and in the far reaching spirit of his humanity (*Magnanimum in nostram congregationem propensae tuae voluntatis studium, & singularem excelsi licèt animi humanitatem*).[3] Guarini states the advantage that the knowledge of the *Placita* may have for Torres as a cleric and a fief; like many of the dedications in Guarini's other treatises, the emphasis is on the connection between cosmos and monarchy; the power of the state and the church, which may be guided by the light of God and by the universal knowledge of the celestial sphere.[4]

The *Placita Philosophica* is an eight-hundred-and-sixty-eight-page treatise. It is a masterpiece of philosophy, establishing a complex system divided into seven books: *Praeparatio ad Logicam* (A Preparation According to Logic), *Physicae* (Physics), *Libros de Caelo et Mundo* (Heaven and Earth), *De Luce* (On Light), *De Generatione e Corruptione* (On Generation and Corruption), *De Viventibus* (On Life) and *Metaphysica* (Metaphysics). The dedicatory foreword of the *Placita*, like many of Guarini's treatises, begins with the fundamental and predominant subject of light; it is in light that his labors may offer the reader the glory of the sun (*in lucem meos labores prolaturus tibi gloriae Soli*).[5]

The first book's demonstration of the importance of logic as a preparatory course of instruction (*Praeparatio ad Logicam*), demonstrates the influence of Guarini's education at the Theatine seminary of San Silvestro. Expensio One, On Limit (*Quid sit Terminus*), defines the three operations of the intellect; those being the auditory understanding of simple concepts, and the extrinsic opposition and acceptance of intellectual ideas; the function of judgment in what we understand; and discursive reasoning, which may to some extent be deductive.[6] The limit, according to Guarini, or the ultimate end of knowledge (*scientia*), is the primary apprehension of that which is initially understood by the mind (*terminus ergo est ille, qui primò per apprehensionem primam concipitur*).[7]

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[2] Guarino Guarini, *Placita Philosophica* (Paris: Augustæ Taurinorum, 1665), (unpaginated). The frontispiece of Guarini's dedicatory forward introduces Torres as: "*Commendatario Ordinis Christi, Commendarum S. Mariae de Montemor, S. Petri finis da Marinha, S. Martini di Frexeida, S. Iacobi di Guidofen, S. Salvatoris de Fornellos, & S. Michaelis de Fornos, Serenissimo Lucitaniae Regi à Consiliis status, ac belli, eiusdemque apud Magnae Brittaniae Regem extra ordinem Legato, & c.*"

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Ibid., 1. "*Notandum 1. tres esse intellecutus operationes: Prima apprehensiva vocatur, & haec simpliciter rem apprehendit, & ab extrinseco obiecto assumens in intellectu ponit. 2. Operatio iudicat de re apprehensa, scilicet, an bona, vel mala sit, an talis, vel talis sit, & haec affirmat, vel negat. 3. est Discursus, qui à re iudicatâ aliquid deducit…*"

[7] Ibid.; Aristotle, *Metaphysics*, trans. Richard Hope (New York: Columbia University Press, 1952), 112. "'Limit means the last point of anything; that is, the first point beyond which it is not possible to find any

The end of knowledge is essentially the beginning; the limit is the ultimate *a priori*. The voice of human intelligence is not the end of being (*scilicet in voce, homo, hominem non esse terminum*); rather to be human, in and of itself, is being and existence (*esse ipsius hominis*).[8]

The subjects of name (*nomine*), verb (*verbo*), and oration (*oratione*), are propositions and their opposites, modes of enunciation, and syllogistics. Syllogistics, as a method of inductive reasoning, brings together the enumeration of singular and combined concepts, in order to arrive at a universal conclusion (*inductio est argumentum à recensione aliquorum singularium ad colligendam conclusionem universalem*).[9] Guarini's explication of this form of logic, originally found in the *Prior Analytics* of Aristotle, is elegantly applied to Catholic theology, in which God the father and Christ are interconnected: *Pater est Deus, Filius est Deus, ergo Pater est Filius*.[10]

Syllogism is evident throughout Guarini's treatises, as well as, most importantly, in his architecture theory itself, in which architecture, light and geometry interrelate within a trinity of their own—God the universe (*Deus*); the architect (*Pater*); and Christ the light (*Filius*); therefore, architecture (*edifizio*), is related to the light of the sun (*orologia*, *gnomonica*) and the geometry (*macchinaria*) and its movement.[11] This system of logic creates a unification of architecture to theology, astronomy, and the cosmos.

The *Placita* continues by defining rational being, universals, identity and distinction, of genus and species, the Aristotelian categories (*praedicamenta*), *accidens*, and measure and relation. The universality of this logic is applicable to the practical methods that constitute Guarini's architecture, mathematics and astronomy. Through syllogistics, universal relates to particular, abstraction to specificity. Metaphysics is an entity of precision for the examination of intellectual work, allowing the grace of the universal word (*metaphysica entia praecisa per opus intellectus consideret, verbi gratía universale*).[12]

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part, and the first point within which all the points are. It means the form, whatever it may be, of a spatial magnitude or of what has magnitude. It means also the end of anything, that to which, not from which, a movement or action proceeds; but sometimes it means both beginning and end. It means, finally, the wherefore, the primary being, the 'what' of anything; for these are the limits of knowledge, and, if of knowledge, then also of things. Thus, it is evident that 'limit' means as many different things as does 'beginning,' and even more; for a beginning is in a sense a limit, but not every limit is a beginning."

[8] Ibid. "*Terminus ergo est ille, qui primò per apprehensionem primam concipitur…Ego verò existimo terminum non esse vocem, seu verbum litteris, syllabisque compositum, quod voce sonamus: sed esse illam vim, quam habet repraesentadi illum conceptum, qui per primam apprehensionem in mente nostrâ habetur; scilicet in voce, homo, hominem non esse terminum; sed illud, quod per vocem hominis intelligitur, scilicet esse ipsius hominis: hoc posito, sit.*"

[9] Ibid., 7. Aristotle, *The Categories. On Interpretation. Prior Analytics*, trans. Harold P. Cook and Hugh Tredennick (Cambridge, MA: Harvard University Press, 1938), 199–223.; Syllogistics is also a topic in Aristotle, *Posterior Analytics, Topica*. ed and trans. Hugh Tredennick and E.S. Forster (Cambridge, MA: Harvard University Press, 1960), 25, 33.

[10] Guarini, *Placita*, 8.

[11] Guarino Guarini, *Architettura Civile* (Torino: Appresso Gianfrancesco Mairesse all Insegna di Santa Teresa di Gesu', 1737), 1. "*L'Architettura secondo i vari generi della fabbriche così variamente distinguesi. Vitruvio al lib. I, cap. 3, la distinse prima in tre, cioè in Arte di edificare, in Arte di fare orologia, o Gnomonica, ed in Mecanica, o Macchinaria…*". Guarino Guarini, *Architettura Civile*, ed. Bianca Tavassi la Greca (Milano: Il Polifilo, 1968), fn., 6. "Vitruvius: *Partes ipsius architecturae sunt tres: aedificatio, gnomonice, machinato*."

[12] Guarini, *Placita*, 13.

The first Disputation, on Whether Logic is Knowledge (*An Logica sit Scientia*), states that reason is that which allows the unification of universal objectivity (*ratio est, quia habet unicum obiectum universale*). The elements of this objectivity become a body put into motion; the physics of the universe (*alia scientia corpus sub ratione mobilis; nisi Physica*), like shafts of corpuscular sunlight penetrating San Lorenzo's fenestrated dome, as the church circumnavigates our closest star from its terrestrial axis.[13]

Book Two pertains to physics (*Physicae*) and how they pertain to the *materia prima*, substantial form, total composition, nature and art, causes, actions, time and duration, infinity, and location and void. Guarini conveys the importance of delineating between the philosophy of physics, mathematics and metaphysics; physics pertains to the perfection of matter (*physicam à materiâ perfectionis*), while metaphysics pertains to matter of abstraction (*metaphysicam ab omni materiâ esse abstractam*), and mathematics pertains to the quantification of matter (*mathematicam à materiali quantitatis*).[14]

The philosophical division between perfection, abstraction and quantification, clarifies these three disciplines by creating a contradistinction, yet their connection is universally apparent as well. Applied to architecture, the perfection of form is dependent on this method of abstraction, as well as quantification, infinitude and mensuration. As infinity is immensurable, quantification becomes possible primarily through the perfection of matter, brought about by the connection of form to universality.

The first universal causation is the *materia prima*. As the syllogistic trinity exists between God as both Father and Son, the *materia prima* exists in the form of three principles: the transmutation of natural bodies according to their first and preeminent cause; this transmutation interacts and envelops existence in a manner that is not always accessible to the senses; and while the *materia prima* is not dependent on physical considerations, it is the root, foundation, and therefore the source of everything sought in nature.[15]

Guarini defines the *materia prima* according to the existence of form (*an materia existat per existentiam formae*). Referring to the metaphysics of his contemporary, Pasqualigum Angelus Bossius (fl. 1665), Guarini defines existence as rational form (*existentia est ratio formalis*), which exists as being, and which connects with other forms. While it is not possible to distinguish existence from essence, nothing is other than essence itself (*nihil est aliud quàm essentia ipsa*).[16]

The definition of *materia prima* leads to disputations on substantial form (*De forma substantiali*), total composition and the unification of created form (*De toto composito*), on nature and art (*De natura, et arte*), on common causes (*De causis in communi*), on action, endurance and movement (*De actione, passione, et motu*), on time and duration (*De tempore et duratione*), and the continuation of composition (*De continui compositione*).[17] The goal of these disputations is to convey the coincidence of metaphysical concepts with physical causation, form and movement in nature, with art and composition of design, the subjects of which are directly related to Guarini's theory of architecture.

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[13] Ibid., 15.
[14] Ibid., 180. "*Aliqui dividunt Philosophiam in Physicam, Mathematicam, & Metaphysicam, desumentes divisiones rationes à diversa abstractione, cum Arist. 2. Phys. à tex. 16. usque ad tex. 18. & 6. Metaph. cap. 1. & 1. de anim. tex. 17 it ut velit Metaphysicam ab omni materiâ esse abstractam; Physicam à materiâ perfectionis, nempe eius, que spectat ad essentialem rei constitutionem; Mathematicam à materiali Quantitatis.*"
[15] Ibid., 183.
[16] Ibid., 184.
[17] Ibid., 197–266.

Disputatio X pertains to infinity (*De infinito*), establishing the position that a continuum of endless points is therefore infinite (*quoniam nonnulli dixere quantitatem ex infinitis punctis constare; ideo de ipso hîc infinito agendum est*). This position on the nature of infinity brings forth an important question of light (*praecedenti quaestioni lucem affermus*). Guarini states that time and eternity are subservient to light itself; even infinity itself may not enter it and is subjected to it. Light exists as that which is beyond the infinite (*etiam quae diximus de tempore & aeternitate subserviemus: cùm ibi non semel, infinitum non posse admitti, supposuerimus*).[18]

Infinity is defined as a philosophical union of the senses, according to all natural possibilty in the mind of the individual (*infinitate individuorum*). Theologically, infinity pertains to the omnipotence of God and the ability to create all things possible (*totus Deus: ergo & de creaturis possibilibus*).[19]

Disputatio XI, on location and void (*De loco et vacuo*), establishes the difference betweeen intrinsic and extrinsic definitions of location and movement. However, the semantics of Guarini's language requires a careful examination; simply translating *loco et vacuo*, as "location and void," lacks the specificity to convey the complex meaning contained in these two terms, which become clearer when considered epistemologically within the framework of the *Placita*.

While *loco* may be defined as 'location,' or "to put something in its proper place," an example of this term is given by extension in the *Oxford Latin Dictionary* as well: "*loco ipsa (mater) arcum pharetrasque*." The phrase was written by the Roman poet Publius Papinius Statius (c. 45–96 AD) and is from the *Achilleid* (94–95 AD), an epic poem about the life of Achilles and translates as "the location of matter itself, as the arrow that extends in form of a quiver." A closer look at Statius' prose reveals why this reference relates back to our original term: *arcum*, is defined as a bow for shooting arrows. *Pharetrasque* pertains to the quiver of the arrow, but by extension, may also be defined as a sundial in the form of a quiver. Therefore, the dial (*pharetra*) is the quiver; the bow and its arrow (*arcus*) are the gnomon. Apollonius of Perga is also credited with the invention of a type of sundial which Vitruvius refers to in *De Architectura* as the "*Apollonius pharetram*."[20]

Vacuo is defined as "something that is empty," or "has semblance without reality, illusory." A contextual phrase is also given: "*vacuo a habendi simulacra*," from Lucius

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[18] Ibid., 267.
[19] Ibid., 270.
[20] P.G.W. Glare ed., *Oxford Latin Dictionary* (Oxford: Oxford University Press, 1982), 1038, 164, 1372.; Sharon L. Gibbs, *Greek and Roman Sundials* (New Haven and London: Yale University Press, 1976), 60–1. "Many commentators on Vitruvius's list have suggested that the terms *arachnen* and *conarachnen* refer to the network of hour lines and day curves on a dial face rather than to a particular type of shadow-receiving surface. *Arachnen* derives from the Greek *αραχνη*, meaning "spider's web," and seems an appropriately descriptive term. The suggestion that the terms refer to some sort of metal fretwork has not, to my knowledge, been supported by archeological evidence. The inventor has been identified as Eudoxos of Knidos, the mathematician and astronomer who flourished about 370 B.C. He is the earliest inventor mentioned by Vitriuvius, and the singularly high quality of his mathematical works makes it plausible that he made basic contributions also to the theory of dialling. The *arachnen* is alternatively atributed to Apollonius [*sic*] who wrote the great treatise on conic sections. He is also credited with the invention of a type of sundial called *pharetra*, 'quiver.'; Vitruvius, *De Architectura*, 320. "*Apollonius pharetram, aliáq; genera, & qui suprascripti sunt, alij plures reliquerunt: ex quorum libris, si quis velit subiectiones invenire, poterit, dummodo sciat anallematum descriptiones.*"

Annaeus Seneca's (4 BC–65 AD) *De Beneficiis*; with *simulacra* being defined as an "image produced by a reflection," "a ghost, or a phantom."[21]

Most likely, Guarini's Theatine education at the Seminary of San Silvestro included reading and possibly being influenced by ancient Roman sources as Statius and Seneca. Nonetheless, Guarini's choice of words reveals something contextually important about the meaning of *Disputatio XI* in relation to gnomonics, the second principle in Guarini's theory of architecture.

The beginning of *Disputatio XI* explains the difference between surfaces, which are bodies in motion (*corporis ambientis*) and the continuum of matter that circumnavigates a central locus (*dicitur continentis, quia locus adaequatus ex omni parte debet circundare locatum*).[22] All distances are connected and fixed to this immovable locus (*omnium distantiam fixam*), this celestial pole which determines the movement of the heavens (*sicut tempus desumitur à motu caeli*).[23]

The celestial sphere is first defined as a cosmographic center point according to its axis, with which Guarini determines latitudinal and longitudinal locations of cities and of building sites, such as Austria, Rome, Domo Lauretana and Lugdunum (modern-day Lyon, France).[24] Here, the celestial sphere is used as a spherical astrolabe, and in the calculation of terrestrial coordinates according to the position of the stars, by which to determine the proper location of the building site.

Guarini also describes the method for determining a building site (*del modo di rilevare i siti*) in *Trattato II* of the *Civile*.[25] Drawing upon Vitruvius, he states that the architect studies the stars and calculates the knowledge possessed by the heavens (*caelique rationes cognitas habeat*) to determine the position of the site to facilitate the accommodation of proper design.[26] The location of the site is determined by the *locus* celestial sphere; the building is designed according to universal specification, its measurements connected to the coordinates of the sphere.

However, the cosmographic relationship between the celestial pole and the location of a building are not merely determined by a physical distance that exists between two tangential bodies (*duobus corporibus non se tangentibus*).[27] The celestial pole is defined as an arm which stands apart and is itself a body which does not move (*ulnis destitissent, etiamsi illa corpora nihil mota fuissent*).[28] Delineating between the idea of *locus* and *vacuo*, Guarini explains that while location is defined by the celestial pole, voidspace is thus illusory (*tanquam in loco aliquo reali, in spatiis imaginariis*).[29]

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[21] Glare ed., *Oxford Latin Dictionary*, 2001, 1766.
[22] Ibid., 274.
[23] Ibid.
[24] Ibid.
[25] Guarini, *Civile*, 45.
[26] Ibid., 48. "*Meritamente Vitruvio ricerca, che l'Architetto* Astrologiam, Cælique rationes cognitas habeat *lib. I. cap. I., che sappi Astronomia, e le ragioni del Cielol; perchè sebbene non dee immergersi nello studio di tale scienza, dee però saperne tanto, quanto basta a conoscere la posizione de' siti, e le sue qualità, per potere, secondo richiede la natura de' siti, così accomodare I disegni. Per darne adunque una prima cognizione.*"; Vitruvius, *De Architectura* (Strasbourg: Ex Officina Knoblochiana, Per Georgium Machaeropieum, 1550), 6. "*Astrologiam cœliq; rationes cognitas habeat.*"
[27] Guarini, *Placita*, 274.
[28] Ibid.
[29] Ibid., 275.

What Guarini describes as empty, illusory or imaginary space (*vacuo*) is defined by the religious historian Mircea Eliade (1907–86), as the primordial homogeneity of space.[30] Eliade describes the founding of the world as a religious hierophany, a break in the spatial homogeneity of the universe, which creates an "absolute reality, opposed to the nonreality of the vast surrounding [*sic*] homogeneous and infinite expanse, in which no point of reference is possible and hence no *orientation* can be established…the hierophany reveals an absolute fixed point, a center."[31]

The purpose of this fixed point, this *axis mundi* is, therefore, not merely cosmographic in terms of defining a physical space or location; it is a symbolic, theological, and therefore, a cosmological location, intended to define one's place and connection to the universe, and to God. In the context of San Lorenzo, the establishment of the center point, this *axis mundi*, pertains to universal design but also includes such liturgical rites, as in the ritual of church consecration, by the smearing of holy chrism on the exterior walls of the church, causing division between sacred and profane.

Book Three, On Heaven and Earth (*Libros de Caelo et Mundo*) begins with a deliberation on the form of universal composition (*delibata rerum universali compositione*). *Expensio I*, *De Sphaerâ Caelesti in Universali*, relates the spatial structure of the sphere to temporality, describing perpendicular lines which all fall to the center of the sphere (*Linea perpendiculariter super illorum plana insistens, cadit semper in centrum sphaerae*), that are then divided into three-hundred-and-sixty parts, then into quadrants and ninety degrees, and divided again into sixty parts, to describe the minutes and hours created by the movement of planets around the sun at the center of the sphere (*quî magis spherae centro approximat: illi minores, qui magis removentur*).[32]

Two figures within the *Civile* pertain to the sphere and to temporality, in relation to the location of the building site, and its relationship to the sun and the solar system, according to its determined position on the earth. The position of a building is determined by its relationship to the celestial sphere, which is found by using a magnetic compass (*bussola della calamita*). Guarini describes the compass as a portable solar clock (*un'Orologio da Sole Portabile*) that finds the position of the building in accordance with the stars by aligning the compass to the meridian.[33]

Guarini also describes this horological system in the *Placita*, stating that the horology of the sun consists of circular projectional planes (*quarum desumitur ab horologijs solaribus, quae aut sunt rotúnda, aut circuli in planú super aliquam superficiem proiecti*), which act as a mathematical instrument to calculate time (*secunda, ex instrument Mathematicis, quae omnia in orbem delineatur*).[34]

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[30] Mircea Eliade, *The Sacred and the Profane: The Nature of Religion*, trans. Willard R. Trask (Reibek, Hamburg and Berlin: Rowohlt Taschenbuch Verlag GmbH, 1957), 20.
[31] Ibid., 21. (Author's italics).
[32] Guarini, *Placita*, 288.
[33] Guarini, *Civile*, 51–2. "*Sarà facile trovare la linea Meridiana, che è la stessa della calamita, a chi avrà un'Orologio da Sole Portabile, Orizzontale, ò Verticale stabile in cui sia la linea Meridiana; perchè se quando ombra dello stile colla sua estremità la rocca, si sospenderà un filo a piombo sopra una tavola posta a livello, che con un lato tocchi 'l muro od un filo equidistante a esso; l'ombra di quello stenderà sopra la tavola la linea Meridiana, e perciò tirata una linea a lungo di essa, quella sarà la linea Meridiana, e la sua estremità piu remota dal piombo quella sarà l'estremità aquilonare, e da tramontana, ove la faetta calamitata si volge, e perciò si guidicherà del sito del muro secondo la precedente Osservazione.*"
[34] Ibid., 194.

Expensio II of *Disputatio III*, *De Horizonte*, describes the nature of horizon with respect to the rising of stars in the heavens. Guarini states that there are, in fact, two separate horizons (*ergo isti duo horizontes*), our visible horizon from our vantage point on earth, and the horizon which divides the heavens into two equal hemispheres (*horizontem semper caelem dividere in duo hemispheria equalia*).[35] Architecturally, this applies to the levelling of the building site, and its alignment with the horizon.

This second, hemispherical definition, brings forth knowledge of the transit of planets between the horizon and the equinox or the zenith and the nadir. This allows one to arrive at the measurement of days (*mensura tú quantitatis dierum*), as the earth and the planets circumnavigate the celestial sphere due to the physical torque of the sun (*quando gyros, quos circa mundum sol torquet*), revealing the variance of days according to the distance and size of the planets (*diesque diuturnitate variat, ut infra*).[36]

Disputatio IV, On the Location, Distance and Magnitude of the Stars (*De Loco, Distantia, Magnitudineque Stellarum*), discusses what one may gain through the use of mathematics as an instrument of measurement for studying the stars (*oportet nos mathematicos profiteri, & iam instrumenta mensoria prae manibus habere, si tamen caelestes affectiones intimiùs perscrutari volumus*).[37] The movement of the stars and their revolution around the celestial sphere pertains to how their rays of light extend forth (*motuum enim illorum volumina, illius lucis extensionem*).[38]

Guarini describes the shadow cast upon the moon as it circumnavigates the earth, and that, like a sundial, can function as a form of gnomonic projection (*luna semper causat umbras alicuius styli maiores; vel remotior oculus noster à stylo, videt lunam vertici gnomonis supereminere immediatè, quàm respiciens solem*).[39] Guarini references Galileo Galilei (1564–1642), and his studies of the moon using a telescope (*siquidem obiecta thelescopio*) in which he observed a variance in the distance of the moon from the earth (*verum non modo tenebrarum & luminis confinia in luna inaequalia, ac sinuosa cernuntur*).[40]

Guarini concludes that the variant distance of the moon is due to an apparent change in velocity; that when the moon appears closer to the earth, it moves faster (*quia quantò magis aliquid oculis nostris vicinum est, tantum velociùs apparet*).[41] Guarini attempts to discover the reason for this, using Euclidean geometry, triangulation and *quadratura* (quadrature), the available methods at a time that still, ever so slightly predate the development of calculus and the theory of universal gravitation by Isaac Newton (1642–1726).[42]

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[35] Ibid.

[36] Ibid.; Ibid., 304. "*...namque corpora nonrotunda, in gyrú se moventia, in equalibus angulus, modò locum reliquunt, modò occupant; ut videre est, si quadratum in orbem torqueatur.*"

[37] Ibid., 307.

[38] Ibid.

[39] Ibid., 308.

[40] Galileo Galilei, *Siderius Nuncius* (Venice: Thomam Baglionam, 1610), 8.; Ibid. Common knowledge of Galileo's lunar observations, is his discovery of craters and mountains on the moon: "*At consimilem penitus aspectum habemus in Terra circa Solem exortum, dum valles nondum lumine perfusas, montes verò illas ex adverso Solis.*"; Guarini, *Placita*, 308. The same observation, of the variant distance of the moon, as it is written in the *Placita*: "*…conspecta viciniora augentur magis, quà remotiora.*"

[41] Ibid.

[42] Guarini, *Placita*, 308. "*Quando igitur ab horizonte Luna faltem 8. gradibus elevata est, collocant Astrologi quadrantem Geometricum qui à longè altitudines mensurat: collocant, inquam, brachio stabili parallelo ab horizontem, se ad Libellam, & mobile elevant ad ipsam Lunam; ita ut radius Transeat per duo piniccidia a*

In observing the conical projection of a shadow cast upon the moon by the earth (*umbra terre sit conica, nempe tanquam pyramis in acumen finiens*), Guarini discusses the movement of shadow and the dilation of light across its surface (*quiá umbra perambulat, ubi dilata magis est*).[43] Guarini maintains, throughout this disputation, a fascination with the effects of illumination from the sun (*illuminans*), the reflected light of the moon (*illuminata*) and how the use of *quadratura* can determine the variation of these effects. The use of conics to determine effects of the sun casting a shadow from the earth onto the moon is elaborated further in the *Euclides Adauctus*, connecting to the intricate study of light through fenestrations in the dome of San Lorenzo, as well as in the geometries which form the structure of the entire church.

Disputatio V, On the Movement of the Celestial Sphere (*De Motibus Spaerarum Caelestium*), describes the movement of planets and stars around the sphere as a compuational machine (*figuris machinamentisque*), their measurement drawn out by their mass and physical momentum (*computum extrahere, nec planetarij laboris mensuras obtinere possimus*).[44] This definition in *Disputatio V*, of the celestial sphere as a machine, relates directly to time (*orologia*), and to movement (*macchinaria*), the second and third premises of Guarini's theory of architecture.[45]

He fortifies his argument concerning the motion of heavenly bodies by referencing not only Johannes Kepler (1571–1630), but also the Carthusian polemist, Lanspergius (John Justus of Landsberg, 1489–1539), referring to their knowledge of the universe as being in constant and perpetual motion.[46] Diameter, sphericity, and eccentricity of the movement of heavenly bodies, translate into the geometries of Guarini's architectural design, forming a simulacrum of the movements and mechanics of the universe. This mechanistic definition of the celestial sphere (*quem calculus ostendebat: unde nedum aliquoties minutis, sed integris gradibus excedebant*), prefigures the Enlightenment, and the publication of Newton's *Principia Mathematica* in 1687.[47]

Disputatio VI, On the Influx of the Heavens (*De Influxibus Caelorum*), describes how the element of time descends onto the celestial sphere and onto the earth as it orbits the sun (*iam tempus est, ut incipiamus descendere, & à caelestibus circulis, ab terrenos*

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vel foramina illius: & in quadrante numerant gradus, incipiendo à lineâ perpencidulari ad brachium stabile, quì tot erunt, quot intercludutor inter lineam AB & lineam CD." Quadrature, which was a method of determing area, was one of the major mathematical advancements that led to the creation of calculus.; Isaac Newton, *Philosophiae Naturalis Principia Mathematica* (London: Josephi Streater, 1687), 4. "*Hasce virium quantitates brevitates gratia nominare licet vires absolutas, acceleratrices & motrices, & distinctionis gratia referre ad corpora, ad corporum loca, & ad centrum virium: Nimirum vin motricem ad corpus, tanquam conatum & propsensionem totius in centrum, ex propensionibus omnium partium compositum; & vim acceleratricem ad locum corporis, tanquam efficiciam quandam, de centro per loca singula in circuitu diffusam, ad centrum, tanquam causa aliqua prœditum, sine qua vires motrices non propagantur per regiones in circuitu; sive causa illa sit corpus aliquod centrale (quale est Magnes in centro vis Magneticæ vel Terra in centro vis gravitantis) sive alia aliqua quœ non apparet.*"

[43] Guarini, *Placita*, 308.

[44] Ibid., 326.

[45] Ibid., 346. From *Expensio VII: De Tempore Solari*: "*Notandum est igitur, tempus Solare distingui communi hominem voce, in Dies & Annos.*"; Ibid., 353. From *Expensio VIII*: *De Motibus Lunæ*: "*...annis etiam Lunaribus tempus mensurate....*"

[46] Ibid., 330. "*Probatur primò, experientiâ. Namque in observationibus Kepleri, Lanspergii, & aliorum, quandoque, immò saepè saepiùs Planetæ non errant in eo situ...*"

[47] Ibid., 1–5.

orbes deprimi).[48] Guarini expresses several theories of time, and how it relates to the emanation of the sun and the propagation of life on the earth (*nam adveniente sole, videmus omnia florere & germinare*).[49] The light of the sun and the movement of the stars, which are seen as both corporeal and magnetic, are part of the influx of time into the universe.

The significance of *De Influxibus*, in relation to Guarini's architecture theory, lies in a philosophical relationship that he creates between light and substantial form. This argument is found in *Expensio VII* (*An astra influant per lucem, tanquam per causam instrumentalem*) and pertains to the design of the structure of the universe (which is finite), according to the influx of light (which is infinite).[50] The perfection, arrangement and finitude of the heavens is predicated upon the visible creation of light, the principal causation of form.

The first premise of Guarini's theory of architecture (*edifizio*) is meant to exist, in form, structure and design, according to the second (*orologia*, *gnomonica*), and third premise (*macchinaria*). The building is meant to be built around the universe, so that light of the sun and the stars flow through it. A work of architecture is a vessel, a container, a conduit.[51]

Standing on the floor of San Lorenzo, looking up at the dome, one finds themselves standing below, and within the celestial sphere, which appears to spin into infinity according to the geometric facets within the lantern and the catenaries that create the complex facets dome. The influx of the universe can be felt when standing within the church, as if San Lorenzo is an astronomical observatory, a telescope in reverse, which draws the universe closer, as opposed to looking outward, farther into the reaches of space.

Disputatio VII, The Earth (*De Mundo*), pertains to the position of the earth, as to whether is it immobile or at the center of the universe. This is a position, through careful discourse, that he systematically argues against by using four examples: the variant position of the stars around the earth, including the occlusion of six stellar coordinates due to the variation of the horizon; the movement of the celestial pole in relation to the rectlinear measurement of the celestial sphere; the diverse locations of lunar eclipses and a knowledge of something that is much like the Newtonian definition of gravity, due to the earth's gyrational movement (a proposition previously set forth by Aristotle's *De Caelo*).[52] Guarini concludes that the sun is the center, around which the earth circumnavigates, while spinning on its axis (*in medio solem, & terram ubi est sol circumgyrantem*).[53]

Book Four, On Light (*De Luce*), attempts to tackle what Guarini admittedly considers a very difficult subject of inquiry. The subject of light has inspired an array of contray opinions in which every philosopher is conflicted (*siquidem contrariis opinionibus, in*

[48] Guarini, *Placita*, 367.
[49] Ibid., 367. Besides being a philosophical argument, *Expensio VII* deals with the physicality of light as heat (*calefactione*), which is part of the process of creating substantial form from light itself.
[50] Ibid., 372.
[51] See Martin Heidegger, "The Origin of the Work of Art" in *Off the Beaten Track*, ed. and trans. Julian Young and Kenneth Haynes (Cambridge, UK: Cambridge University Press, 2002), 20. "Through the temple, the god is present in the temple. This presence of the god is, in itself, the extension and delimitation of the precinct as something holy. The temple and the precinct do not, however, float off into the indefinite."
[52] Guarini, *Placita*, 387–88.
[53] Ibid., 388.

omnibus ad invicem pugnan); it is light itself which seems to obscure its own knowledge in shadows (*ipsâ luce tenebras offundunt*).[54]

Expensio I pertains to whether light is substantial or an occurrence (*An Lux sit Substantia, vel Accidens*) and begins by referencing the writings of Empedocles (c. 490–430 BC) on Aristotle's *De Anima*, as well as Epicurus (341–270 BC) and Lucretius (99–55 BC), who define light as corporeal being (*affirmarunt lucem corpus esse*).[55] The first problem discusses the impossibility of light being a corporeal body and if it is able to pass through a diaphanous body. The second problem pertains to the transmigration of light from one location to another (*transmigratio lucis de loco ad locum*), the generation of light (*vel est generatio lucis*) and the movement of its own generative location (*vel motus localis ipsius*). He concludes that light migrates from one location to another and does not generate at each location; rather, it is by extension and from a single source from which light emanates, and it is for this reason as well, that light cannot be a corporeal body.[56] In referencing the theology of Saint Augustine (354–430 AD), Guarini presents a contradistinction to this argument in which light and location are thought of as a synechdoche (*per synechdocen esse locutos*); while light is fundamentally an occurrence, the effect of coincidence (*per accidens*) is seen as part of a whole.[57]

Expensio VII pertains to the physics of light. Guarini attempts to answer whether light is produced instantaneously or moves within a span of time (*quaesiuimus supra de motu lucis, an se, in se movendo, instantaneé, vel successivè se moveret*), as well as whether the speed of light travels as a wave or moving particle (*nam lux movetur, fluctuat & concutitur, prout corpus luminosum vel fluctuat vel concutitur*).[58] Guarini observes that light does, indeed, move (*motus verò in luce*) but maintains, as he states earlier in the treatise, that light is a perfect substance, a substance which exists prior to everything else in nature (*lucis antecendens ad ultimam, sit eiusdem naturae*).[59]

Only eleven years after the publication of the *Placita*, the Danish astronomer, Ole Christiansen Rømer (1644–1710), along with Jean Picard (1620–1682) and Giovanni Domenico Cassini (1625–1712), made observations that light travels at a constant velocity and made an approximation of its speed by comparing the propagation of light from Jupiter, with the earth at two different distances from it.[60] Cassini quantified Rømer's findings, stating that the velocity of light is "more than 600,000 times greater than that of sound."[61] Rømer and Cassini presented their findings to the French Academy of Sciences seven years later, in 1683.[62]

The subsequent chapters of *De Luce* (*Disputatio II–VIII*), pertain to the fundamental nature of light (*De Lucis Subiecto*), the luminous body (*Productione Corporis Lumi-*

[54] Ibid., 397.
[55] Ibid., 398.
[56] Ibid., 399.
[57] Ibid.
[58] Guarini, *Placita*, 407.
[59] Ibid.
[60] Bobis and Lequeux, "Velocity of Light," 97.
[61] Ibid., 100.
[62] Marin, Gabriel, Jean-Baptiste Coignard and Hyppolyte-Louis Guerin, *Table Alphebetique des Matieres Contenues Dans l'Histoire & les Memoires de l'Académie Royale des Sciences, publiée par son Ordre. Tome Premier, Anne'es 1666–1698* (Paris: Par la Compagnie des Libraires, 1734), 313.

nosi), the production of heat from light (*De Productione Caloris*), the division of the species of light into color (*De Delatione Specierum, vel Colorum*), the modification of light (*De Modifactionibus Lucis*), and the absence of light (*De Defectu Lucis*). Guarini's intricate knowledge of light reflects his fascination with this simultaneously diaphanous, yet corporeal substance, which, according to him, supercedes the existence of all else in the universe. Light signifies the presence of God, the rainbow in the clouds (*arcum meum ponam in nubibus*, Gen. 9:13), the spectral division between unity and plurality, the coincidence between heaven and earth.[63]

Book Five, On Generation and Corruption (*De Generatione e Corruptione*), is based on Aristotle's treatise of the same name. The book begins with a disputation on the nature of the elements. The problem of generation and the existence of reason prior to the composition of elements (*in ratione enim mixti, priùs componitur ex elementis*) leads next to the *Physiologia* of Jean François Fernel (1497–1558) and to Aristotle's discussion of the axiomatic in the *Metaphysics*. Guarini furthers Fernel's argument that the elements exist as the various parts of the body, with Aristotle's view that axioms are beyond a limited form of knowledge because they concern primary being, for according to Aristotle, the principles of primary being are based on the principles of reason.[64] As in *De Luce*, Guarini relates the elements (*elementi*) and their parts (*componitur*) to the substantial (*substantia*) and the occurrent (*accidens*) a line of reason which echoes, once again, Alberti's theory of architecture and the *concinnitas*, but within the realm of the biological and the physiological as opposed to the luminous and the optical.

Guarini points to the fire of the sun and of the other stars as the ultimate substantiality. Fire is not a simple body and is, therefore, not an element (*ignis non est corpus simplex: ergo neque elementum*) but a substance above all substances (*substantia supra substantiam*).[65] The fire of the sun is a point of light (*unum punctum luce*); like an illuminated mirror creating circular and parabolic facets in the reflections of its lens (*collustratum* [*sic*] *nec parabolicum, sed circulare vidisse omne combustibile accendens*).[66]

Disputatio II pertains to atmospheric phenomenon (*De Meteoris*). Guarini places the composition of the elements in the context of nature, time and diurnal planetary movement (*cum tamen natura in omnibus aliis tempus amet, & diuturna per dispositionem augmenta opus suum moliatur*).[67]

Expensio IV, On the Rainbow, *De Iride*, is an extension of his theory of light in *De Luce* which deals with spectrum and refraction according to prisms and spheres. The intricate surface or falling water composed of particles of mist creates spectral radiance upon the surface of the eye against the darkness of shadow (*in iride, impediret etiam ne pluvia ante oculos tuos positae radios solis vivaces, cùm umbram causaret*).[68] The direct light of

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[63] Guarini, *Placita*, 435.; Roger Gryson, ed. *Biblia Sacra: Iuxta Vulgatam Versionem* (Stuttgart: Deutsche Bibelgessellschaft, 1969), 14.
[64] Jean Fernel, *The Physiologia of Jean Fernel (1567)*, trans. John M. Forrester (Philadelphia: American Philosophical Society, 2003), 186–92.; Aristotle, *Metaphysics*, trans. Richard Hope (New York: Columbia University Press, 1952), 67.
[65] Guarini, *Placita*, 472.
[66] Ibid., 474.; John Hendrix, *Architectural Forms and Philosophical Structures* (New York: Peter Lang Publishing, Inc., 2003), 92. "Guarini describes geometry as the mirror of the world, and, combined with mathematics, geometry is the basis of scientific investigations."
[67] Guarini, *Placita*, 491.
[68] Ibid., 496.

the sun is not the source of spectral irridescence; an inversion of color creates the rainbow (*nam radii directi ab ipso sole esse non possunt: tum quia secunda iris inversus coloribus apparet*), caused by particles of water expanding into spheres of aqueous reflectivity (*istaeque guttulae radios non coloratos in alios superstantes globulos aquaeos reflectant*).[69]

The following arguments in *De Meteoris*: On Winds (*De Ventis*); On Clouds (*De Nubibus*); On the Solidification of Water (*De Aqueis Concretionibus*); On the Movement of the Ocean (*De Motibus Maris*); How the Salt of the Sea Was Formed (*A quo Salsedo Enascatur*), The Origin of Water and How it Flows (*De Origine Fontium, Atque Fluviorum*) are a careful exposition on the biological, meteorological constituents of the earth and its elements.

As in *De Luce*, Guarini points to the sun as the source of primary causation in connection with every other element. All of creation, in a metaphysical sense, is a refraction of the sun, a spectral inversion of a burning mirror. The metaphysical aspect is connected to the theological (in his reference to the *Hexaemeron* of Saint Ambrose) and grounded in the physiological and the biological. The teleological connection between the heat of the sun and the dimensions it creates within the air, the orbit of the moon, the appearance of comets and all meteorological phenomena are caused by the rational dimensions of its radiance.

A number of other treatises concerning light and meteorology were published around the same time as the *Placita*. The treatise *De Lucidis in Sublimi Ingenuarum Exercitationem Liber* (1641), by Fortunio Liceti (1577–1657), expresses this with elegance, stating that the earth is connected to the reflected radiance of the sun (*terra subiacente solarium radiorum reflexio*).[70] The sun pulls on the moon, which affects the waters of the ocean and the winds upon the earth (*id exequi à luna è a sole simul, non per virtutem vel rarefactivam, vel tractivam*).[71]

Guarini's knowledge of the moon being pulled on by the sun predates Newton's Theory of Universal Gravitation. However, there is yet another claim, other than the velocity of light as a constant and the movement of light as a perturbance or wave that Guarini makes, that places him and his contemporaries ahead of their time: that light travels from the sun to the earth in a vacuum (*coniuncta soli est: unde vacua luce*) until it reaches the atmosphere, creating heat, wind, and the movement of the ocean, a concept that would be developed further by Albert Einstein (1879–1955) and the Theory of General Relativity.[72]

Disputatio III and *Disputatio IV* discuss the combination of the elements according to generation and corruption (*De Generatione: Mixtorum*). *Disputatio V* explores the topic of change (*De Alteratione*). *Disputatio VI* investigates rarefaction and condensation (*De Rarefactione et Condensatione*). *Disputatio VII* explains natural and violent movement in nature (*De Motu Naturali et Violento*). *Disputatio VIII* explores the perceived properties of combined elements (*De Qualitatibus Mixtorum Sensibilibus*). *Disputatio IX* delves into the combining of specific inanimate elements (*De Mixtis Inanimatis in Particulari*).

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[69] Ibid., 497.
[70] Fortunio Liceti, *De Lucidis in Sublimi Ingenuarum Exercitationem Liber* (Padua, Italy: Typis Cribellianis, 1641), 4.; See Appendix.
[71] Guarini, *Placita*, 506.
[72] Ibid.; Albert Einstein, *Relativity: The Special and the General Theory* (London, England: Methuen and Co. Ltd., 1920), 36–7.; Ibid., 504. See *Expesio IX*, *De Motibus Maris*.

Book Six, On the Subject of Life (*De Viventibus*), begins by asking the question in *Expensio I*, of What is Life and What is One's Essence Founded Upon? (*Quid est Vita? & in Quo Eius Essentia Sita Sit*). It is an essentially ontological question, echoed by Jean-Paul Sartre's (1905–1980) *Being and Nothingness* and Martin Heidegger's (1889–1976) *Sein und Zeit* in the twentieth century. However, Guarini's focus is more clearly theological, physical and biological—not existential. However, like existentialism, as well as phenomenology, Guarini's philosophy has a great deal to do with sense perception, the subjectivity of experience in the moment, and the potentiality of the human being (*nam aliqui sensere, sitam essem in operatione per se immanente, quâ res non constituereturin statu sibi debito in primo existentiae instanti: ad hoc ut excludant emanationem potentiarum*).[73]

The various kinds of living creatures, whether angels, humans, animals or plants, all exist according to different metaphysical, vegetative, sensitive and rational distinctions (*varias distinctiones metaphysicas vegetativa, sensitiva, rationalis*).[74] Life is created from one but exists as the multitude and as a continuum (*actum vitae debere esse continuum*).[75]

Disputatio II, On the Life of the Body (*De Viventibus Corporeis*), begins by defining life within the human body as it exists as a substantial and rational being. It is not sufficient to consider the relationship of the soul and the body a coincidence (*accidentalis non sufficit*), but they are essentially distinguishable, and, in fact, not dependent on one another (*eò quòd sit corpus, à spiritu essentialiter distinguitur: ergo per nullam dependentiam, vel relationem ab quantitatem, substantia potest dici corpus*).[76]

Disputatio III, On the Soul in Communion (*De Anima in Communi*), begins by defining the soul. Guarini argues against Aristotle's theory that the soul is physical, existing within the organization and teleology of nature, stating instead that the body is physical, and designed according to nature but is, therefore, not a suitable material for the soul (*cadaver est materia physica, & organizata: & tamen non est apta materia anime: ergo*).[77] Rephrasing Aristotle's *De Anima*, in which he defines the potential of the existence as life (*potentiâ vitam habentis*), Guarini states that it is life itself that is the potentiality of existence (*vitam potentiá habentis*).[78]

Guarini's knowledge of the soul speaks to his relationship to architecture as, once again, the focus is on unity and multiplicity and above all to the light of the sun, which is compared to the emanation of the soul within the body (*quare illum accidens coproreum erit, quod aut à causa corporea emanat*).[79] It is an ontological question of existence, which is placed upon the experience of the individual within the church (*edifizio*) as a vessel of illumination, to commune with the sun (*orologia*) and its movement (*macchinaria*). Time and eternity are subservient to light; light exists beyond the infinite, connecting the soul to God, with the church as its terrestrial instrument.[80]

The following chapter in Book Six is *Disputatio IV*, The Life of the Spirit (*De Spiritibus Viventium*), which begins by defining spirit and whether or not the spirit may be found in all living things. He makes a distinction between plants and animals, stating that

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73 Guarini, *Placita*, 611.
74 Ibid., 613.
75 Ibid.
76 Ibid., 617.
77 Ibid., 628.
78 Ibid.
79 Ibid., 618.
80 Ibid., 267.

while many plants have a medicinal effect on the body of an animal or human, the spirit, which he describes, is something that is present within blood (*ex sanguine diversa promanant; qui spirituosae substantiae*).[81]

Disputatio V, On the Generation of Life (*De Viventium Generatione*), discusses procreation and the propagation of species and genera of various *animalia*—what is essentially a brief theory of evolution that predates Charles Darwin (1809–1882) by over two-hundred years. The disputation begins, like Adam calling the animals by name, with Guarini pointing to the multitude of animals upon the earth and fish within the sea (*terras unius species non esse, sicut nec aquas; sed multas species à principio Deum tum terris, tum aquis indidisse*).[82] He continues by stating that living creatures possess a hidden potential and that the beauty of their creation pertains less to coincidence (*accidens*) and more to do with this hidden internal power (*potentias occultas in rebus posse servari: & licèt minùs nobiles quoad suorum accidentium exhibitionem, posse tamen potentiam servare internam*).[83] He defends this argument with the Bible and with the Hexameron of Saint Ambrose, who states that God's creation is imparted according to the law of nature, which the earth as a vessel endures, bringing forth the future of existence (*Dei singulis creaturis gignendis impertita, naturae lex est, quae terris in aenum permansit futura successionis datura praescriptum*).[84] The spirit created by the flow of blood through the body (*spirutus in corpore*), the organs (*organorum*), muscles and membranes (*musculus enim, ut trahat membrum*) the nervous system (*nervos*), and the optic nerve (*nervis opticis*), causes the creation of heat within animals and humans as well.[85]

Guarini's argument for evolution is not solely theological, but also biological. As in Darwin's *Origin of Species*, Guarini studies various species, the effect of the environment in which they live, and how they interact.[86] He writes on the transmutation of species, and that this movement in nature, this alteration, may be caused by bifurcations within the *materia prima*, as it is guided by this hidden potential.[87] However, differently than Darwinian evolution, Guarini's theory is not based on competition, but rather the transmutation of this primary element, the hidden potential of nature.

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[81] Ibid., 538.
[82] Gryson, ed. *Biblia Sacra*, 6. (Genesis, 2:19–20). "*formatis igitur Dominus Deus de humo cunctis animantibus terrae et universis volatilibus caeli adduxit ea ad Adam ut videret quid vocaret ea omne enim quod vocavit Adam animae viventis ipsum est nomen eius appellavitque Adam nominibus suis cuncta animantia.*"; Guarini, *Placita*, 643.
[83] Ibid.; Marsilio Ficino, *All Things Natural: Ficino on Plato's Timaeus*, trans. Arthur Farndell (London: Shepheard-Walwyn Publishers, Ltd., 2010), 28. In comparison, Ficino provides another theory involving generation and corruption, and the evolution of forms in nature in his commentary on the *Timaeus*. "Within the world we see not only a differentiation of forms, but also a state of opposition; for the world comes forth from the First, and as it comes forth it declines. Indeed, the outward movement causes differentiation, and the decline causes opposition. The fact is that the origin of the division is the fecundity of the cause, overflowing on all sides and spreading far and wide; but as the division moves forward in many steps, it eventually reaches the state of opposition, especially since the material of the world is unable, on account of its own weakness, to reconcile the forms in the way that the higher world reconciles them with itself. Thus it came that God spread forth matter and measured it out in order to collect, at various resting points, forms which are likely to be mutually opposed…the opposing qualities and forms of the heavens are conducive to the daily begetting of new forms through the variation of movement."
[84] Ibid.
[85] Ibid., 639.
[86] Charles Darwin, *The Origin of Species* (New York: P.F. Collier & Son, 1909), 58–62.
[87] Guarini, *Placita*, 652.

Disputatio VI, On the Faculties that Nourish Life (*De Altrici et Auctrici Facultate*), begins by discussing the aspect of heat (*calorem vitalis*) within the lifeblood of living organisms. He theorizes that the heat within living bodies may descend from the heavens and from the light of the burning sun (*si calor vitalis in animalibus à calore caelesti descenderet*) or that it may be produced of its own accord by the arterial pulsation of the body (*calor vitalis ex pulsatione cordis arteriarumque in ipso corpore enascitur*).[88]

Disputatio VII, On the Senses of the Soul (*De Anima Sensitiva*) discusses whether the senses of the soul are indivisible (*sit indivisibilis*) or if they exist as one (*omnis anima sensitiva*).[89] The soul is the perfection of the living creature; its potential is evident in the organization of its body (*animae etiam animalium perfectorium, potentiae quaedam sunt in materia organizata*).[90]

This argument leads to an explanation of whether or not the vision of the eye is material or sensorial. The unity of the soul is light as it enters through the organ of the eye (*oculos*). The determination is made between a formal or visual image, dependent on the transparency perceived through the lens of the eye and the crystalline humor (*diaphaneitas, & lens, qualis figurae est humor chrystallinus*).[91] A very careful and detailed explication on the anatomy of the eye and how it perceives light exists in *Disputatio VII* in a manner that differs from Book Four, *De Luce*. Object (*obiectum*) and perception (*perciperet*) are intricately related to the organ of the eye and to the body's orientation within space (*solis, per foramen, in locum obscurum ingrediens videtur*) and its affectation to the color of light (*lux colorata admittur oculum*).[92]

Disputatio VIII, On the External Senses (*De Sensibus Externis*), begins with *Expensio I*: On the Eyes as the Miracle of Architecture (*De Oculi Mirabili Architectura*), directly connecting the optical principles spoken of in *Disputatio VII*, with the art of building. He begins by defining the eight parts which constitute the anatomy of the eye: muscles (*musculis*), membranes (*membranis*), fluids (*humoribus*), nerves (*nervos*), arteries (*arterias*), veins (*venas*), flesh (*carnem*) and corpulence (*adipem*).[93]

Guarini creates a connection between the anatomy of the human eye and the formation of the interiority and exteriority of architecture, according to rotundity, height, *epicanthus* (asymptote) and time.[94] The architecture of the eye (interiority), reflects the architecture of building (exteriority). The eyes are the totality of the building's structure (*haec est oculi totius fabrica*).[95]

He describes the layer underneath the choroid, where the optic nerve exists that brings forth a network of veins upon the black surface of the pupil, connected to the crystalline humor, which is, therefore, connected to the cornea, giving form to the diverse colors of the iris. He depicts the pupil as a structure effected by a spinning motion, like the torque created by the earth spinning on its axis (*circa eam velut iridem in ambitum torquet*).

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[88] Ibid., 672.
[89] Ibid., 701.
[90] Ibid., 702.
[91] Ibid., 703.
[92] Ibid., 704.
[93] Guarini, *Placita*, 711.
[94] Ibid., 711. "*Partes exteriores ita humanum oculum, omniumque quadrupedum obtegunt, ut quamvis rotundi eos tamen in latum discooperiant magis, quàm secundum altitudinem: unde duo oculi Canthi, interior, maior ad nasum, rotundusque; exterior, minor & acutior ad tempora, efformantur.*"
[95] Ibid., 713.

The pigmented layer of the eye (*uvea*) that lies underneath the cornea appears to rotate, creating variation of color within the pupil (*sit ut subtus corneam apparet in gyrum uvea; quae cum pupillam, nempe foramen in medio habeat…iris vocatur, propter varietatem colorem pupillam ambientium*).[96]

The intricacies of optical perception within space directly connect the eye as the instrument of vision to the machine (*macchinaria*) that is the movement of light (*orologia*, *gnomonica*) within the Church of San Lorenzo (*edifizio*). When looking up toward the interior of the dome, another aesthetic comparison may be made other than that of the celestial sphere: a simulacrum of the eye—an oculus, the octagonal lantern representing the pupil; and the interlaced catenaries and geometric fenestrations in the shape of lunettes and pentagons, representing the colorful pigmented layer below the uvea (*iris vocatur, propter varietatem colorum pupillam ambientium*).[97]

Variations of luminous color are created through the multidirectional refraction of light created in the space between exterior and interior, relating to the convexity of the eye's exterior and the concavity of its interior (*exterius convexum, interius concavum*), causing the furthest of surfaces to appear within the eye's innermost anatomical structure (*superficies extima intimaque*).[98] The complex interlacing of geometries and *muqarnesque* patterning in the *cupolino* create a spinning effect, like the rotation of stars around the *axis mundi*, pointing to the zenith. The dome of San Lorenzo, resembling Guarini's anatomical description of an eye, is a mirroring instrument of the universe, the lens of the soul.[99]

Guarini's complex description of the 'architecture' of the eye, as well as the intricate description of the celestial sphere, must have had a great influence on Guarini's design for the dome of San Lorenzo, which he was commissioned to build in 1668, just three years after the publication of the *Placita*.

Disputatio IX, On the Internal Sense (*De Sensibus Internis*), begins by describing the behavior of animals, involving muscular constriction, expansion and movement, the nervous system and organs. Guarini wants to find the causation of physical movement among animals and humans, whether caused by a complex interaction within the organism, by the spirit or the imagination. He once again points to the sun as the source of movement among physical beings, stating that extension of the sun's light causes their movement (*ergo solae species excurrunt ad musculos movendos*), giving speed to their imaginations, thus generating power (*quòd non tam celeriter ab imaginatione generari potuerint*).[100]

Disputatio X, On the Desire of the Senses, and on Instinct (*De Appetitu Sensitivo, et Instinctibus*) pertains to the causation of emotion and passion in various physical species (*de affectibus*).[101] Guarini references Aquinas, pointing to concupiscence as the cause of

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[96] Ibid., 712.
[97] Ibid., 712.
[98] Ibid., 716.
[99] Hendrix, *Robert Grosseteste*, 157.; John Hendrix, *The Relation Between Architectural Forms and Philosophical Structures in the Work of Francesco Borromini in Seventeenth-Century Rome* (Lewiston, Queenston, Lampeter: The Edwin Mellen Press, 2002), 46.; Noé Badillo, "Ocularium Lucis: Light and Optical Theory in Guarino Guarini's Church of San Lorenzo" (MA Thesis: The University of Arizona, 2012), 81.
[100] Guarini, *Placita*, 758. Guarini's theory on the movement of physical species also points to the behavior of "heliotropium," plants which point their flowers or branches in the direction of the sun. This kind of movement, as well as the relationship between animals and the light of the sun, relates to the idea of gnomonics and the human desire to follow the direction of the sun.
[101] Ibid., 704.

passion. He writes on love and hate (*De Amore, & Odio*), stating that all love that is not Platonic is a desirous longing for beauty (*desiderium pulchri*). Because of physical deprivation, it causes a meeting of bodies (*sed etiam privationes ipsae, dummodo nobis conveniant*).[102]

Disputatio XI, On the Movement of Animals (*De Motu Animalium*), describes the movement and behavior of animals based upon the various muscle groups, tendons and nerves of the body and differentiates between the movement of humans and other species. Guarini describes physical movement based on the nervous system, which divides into a network known as the meninges, the three membranes the envelop the brain and the spinal cord. Guarini states that the movement of the optic nerve below the cortex is made up of multiple substances that participate in vision through their connection with the meninges (*qui musculis oculi inseruntur; & tamen meningis plurimam substantiam participare videntur, cùm sint solidi & fortes*).[103]

Guarini's studies of the optic nerve and its connection to the brain, the spine and the anatomy of the body are echoed in the intricacy of his architectural designs. The complexity of San Lorenzo's dome reflects Guarini's knowledge of optics and physiology. A complex understanding of the anatomy and physiology of the eye and the brain creates a tangible understanding of how the intricacies of optical perception occur. The relationship of San Lorenzo to the sun is fortified by Guarini's understanding of optical anatomy as the instrument of vision with which the light of the sun is perceived. As Goethe wrote in the *Xenion*, "If the eye was not like the sun, it could not behold the sun" (*Wär nicht das auge sonnenhaft - die sonnen könnt'es nie erblicken*).[104]

Book Seven, Metaphysics (*Metaphysica*), begins by attempting to define the object of metaphysics in *Disputatio I*. Guarini delineates between physics, which pertains to what is seen (*quae ad physicam spectat*), and metaphysics, which is defined as a knowledge of the supernatural (*scientam scilicet supernaturalem*).[105] In furthering his search for a proper definition, he quotes Albertus Magnus (1200–1280), who states that metaphysics is a science above all other sciences and Thomas Aquinas (1225–1274), who states that metaphysics considers knowledge (*scientia*) according to the highest intelligible cause, which is God (*consideret causam altissimam, nempe Deus*).[106]

Disputatio II, On Being (*De Ente*), begins by defining what being is (*Quid sit Ens?*). Guarini states that being is determined by what extent we exercise the significance of our own existence (*si assurmatur ut participum, significat exercitium existentiae*).[107] To exist is to act; to comprehend is threefold, according to time in the present, without the presence of time, or only according to existence itself (*existere actu, tripliciter intelligi. Vel ut conntat tempus presens…vel ut nullum presens cónotat, sed dicam solo existentiam*).[108]

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[102] Ibid., 743.
[103] Ibid., 759.
[104] Johann Wolfgang von Goethe, *Xenien 1796. Nach den Handschriften des Goethe- und Shiller- Archivs hrsg. von Eric Schmidt und Bernhard Suphan. Mit einem Facsimile* (Weimer: Goethe–Gesselschaft, 1893), 104.
[105] Guarini, *Placita*, 827.
[106] Ibid. "*…Tractatus post Physicam tradere solebat. Sed, ut afferit Albertus Magnus cap. 1. Suae Metaph. etiam Metaphysica appellatur, quia supra scientias caeteras elevatur. Ideo erigeda est mens, & ampliora capienda, dilatanda.*"; Ibid., 829.
[107] Ibid., 835.
[108] Ibid., 836.

Being is nothing other than being, which, according to action, exists (*ens nihil aliud est, quàm quod actu existit*).[109]

Guarini's ontology is a very self-affirming thesis and one that may be seen in the light of Heidegger and Jean-Paul Sartre (1905–1980); one that may also be a better understood position on existential nihilism than its misappropriation as a form of hopelessness, despair and voided meaning; one that reflects upon an existence founded upon a void which is being, or *Da Sein*.

The opening lines of Genesis describe God creating light from void and emptiness (*terra autem inanis et vacua et tenebrae super faciem abyssi et Spiritus dei ferebatur super aquas. Dixituqe Deus fiat lux et facta est lux*, Gen. 1:2–3); light, in the philosophy of Guarino Guarini, is the perfect substance that exists prior to all else in nature.[110] It is that which, according to Genesis, gives the void and formless earth the division of day into night (*divisit lucem ac tenebras*, Gen. 4:4), a rather horological, gnomonical principle, signifying the movement of the sun across the sky and, at the conclusion of the day, revealing the nocturnal firmament (*vocavitque Deus firmamentum caelum*, Gen. 4:7).[111]

Disputatio III, On Being and Suffering (*De Passionibus Entis*), begins by asking the question as to whether being is suffering and whether it is due to consequence (*an ens passiones, & quasnam, consequatur*).[112] This is first and foremost determined by asking whether being as being is adequate (*quod in essentia entis non includatur, distinguaturque ab ipso inadequatè*).[113] Guarini states that this inadequacy is dependent on whether or not being reaches perfection, predicated on the idea of unity, beauty and abstraction. The connection of diverse forms of being is essentially connected to one's exigent desire for God (*dicit tamen formalitatem diversam à singulis, nempe essentialem exigentiam in Deo*).[114]

The unity of being exists beyond logic (*supra in logica*); it exists as the full brunt of the full weight of God's given light (*expensionibus in lucem dedimus*). Unity of being is in the nature of things and a part of things, the intellect of which is a part that is built over it and built upon it (*unitas sit ex naturâ rei, & à parte rei; aut sit necesse quod intellectus aliquid ei superstruat & fabricet*).[115]

Disputatio IV, On the Matter of Essence (*De Essentis Rerum*), attempts to define the meaning of essence. Guarini states that essence is what was possessed the moment immediately after God's principal creation. Essence is that which is rekindled by the creative intellect from actual being (*essentiae relucentes in intellectu creato, sunt ens actuale*).[116]

Referencing the *Metaphysics* of the Jesuit philosopher and theologian Francisco Suárez (1548–1617), Guarini concludes the *Placita* by stating that the foundation of existence and its enjoyment is destroyed without the destruction of its foundations. For nothing is, in fact, destroyed, with the qualification of departure, but the entities of things in their

[109] Ibid.
[110] Gryson, ed. *Biblia Sacra: Iuxta Vulgatam*, 14; Ibid., 407.
[111] Ibid., 14.
[112] Guarini, *Placita*, 850.
[113] Ibid., 852.
[114] Ibid.
[115] Ibid., 853.
[116] Ibid., 859.

own transformation (*debere propria existentiâ frui; quòd sine destructione subiecti destruantur. Namque nihil destruitur, cum modus facessit: sed entitas rei in se-ipsâ mutatur*).[117]

Although the *Placita Philosophica* predates the posthumous publication of the *Architettura Civile* by over seventy years, the germination of knowledge which is to develop into Guarini's theory of architecture is ever present within this treatise. What may be seen in tandem, given the timeframe of the treatise, is the burgeoning development of the history of science along with the history of architecture, as Guarini's profoud and prescient knowledge, written during the late Baroque period, moves swiftly towards the Enlightenment and the Neoclassical Period. The philosophical system of the *Placita* (logic, light, space, anatomy, the heavens and the metaphysics of being) is interpreted within a didactic, pragmatic and structural framework in Guarini's architectural production up to this point. This includes the design of Saint-Anne-la-Royale and then in San Lorenzo, the project for which he would be commissioned in 1668, three years after the publication of the *Placita*.

[117] Ibid., 868.; Aristotle, *Metaphysics*, 11. This concept originates in the work of Aristotle who references Anaxagoras and Empedocles, stating that "nearly all things whose parts are like themselves, such as water or fire, are thus generated and destroyed by combination and separation only; otherwise they are not generated or destroyed, but remain forever." Therefore, generation and destruction is only elemental; the primary substance remains, inseparable and eternal; the generation and destruction of elements is only a transformation.

APPENDIX IV

EUCLIDES ADAUCTUS

Euclides Adauctus (The Advancement of Euclid) was published in 1671 by Augustae Taurinorum and dedicated to Carlo Emanuele II, Duke of Savoy from 1638 to 1675. Guarini wrote the *Euclides* as a demonstration of universal mathematics and as a presentation to the Duke concerning "the miracle of mathematics which brings forth the brilliance of royal architecture."[118] A multitude of mathematicians from antiquity as well as those contemporary to his own time are referenced in the treatise.

The *Euclides* is comprised of thirty-five tracts written in 686-pages, excluding sine tables, appendix and index. The tracts are as follows: *Tractatus I*, On Continual Quantity (*De Quantitate Continua*); *Tractatus II*, On Separate Quantities (*De Quantitate Discreta*); *Tractatus III*, On Mathematics and the Will (*De Mathematica & eius Affectionibus*); On the First Book of [Euclid's] Elements (*In Primum Librum Elementorum*); *Tractatus V*, On the Second Book of the Elements and the Equipotentiality of the Line (*In Secundum Libru Euclidis, de Aequipotentia Linearum*); *Tractatus VI*, On book Three of the Elements, The Circle (*In Librum 3 Euclidis de Circulis*); *Tractatus VII*, On Book Four of the Elements, the Inscription and Circumscription of the Figure of the Circle (*In Librum 4 Elementorum de Inscriptione & Circumscriptione Figuram in Circulo*); *Tractatus VIII*, On Simple Arithmetic and the Interrogation of Numbers (*De Arithmetica Simplici Interrogam Numerorum*); *Tractatus IX*, Part One on Euclid's Fifth Book on the Notion of Proportion (*Pars I. in 5. Euc. lib. de Proportionum Notione*), and Part Two, on General Proportion (*Pars 2. De Proportionib. in Genere*); *Tractatus X*, On Book Six of the Elements, the Proportion of Continual Quantity (*In 6. lib. Euc. De Proportione Quantitati Continua*); *Tractatus XI*, Part One of Book Seven of the Elements, On the Proportion of General Numbers (*In 7. Lib. Euc. Par. 1, De Proportionibus Numerorum in Genera*), and Part Two, On the Proportion of Special Numbers (*De Spetiali Numerorum Proportione*); *Tractatus XII*, (untitled); *Tractatus XIII*, On Numerical Proportion (*De Numeris Proportionalibus, Pars. 1*); *Tractatus XIV*, On the Proportion of Numerical Continuity (*De Proportionibus Numericis Continuis*), and Part Two, On Continual and Arithmetical Proportion (*Pars. 2. De Proportione Arithmetica Continua*); and Part Three, On the Proportion of Harmonics in Continuity (*De Proportione Harmonica Continua*); *Tractatus XV*, On the Proportion of Lines and Segments (*De Linearum, Segmentorumque Proportionibus*); *Tractatus XVI*, Part One, On the Linear Progression of Geometry (*De Linearum Progressione Geometrica, Pars 1*), and Part Two, On the Linear Progression of Harmonic Geometry (*De Linearum Progressione Harmonica*); *Tractatus XVII*, On Rational Proportion (*De Proportionalitatibus Rationum*); *Tractatus XVIII*, (untitled); *Tractatus XIX*, On Angles (*De Angulis*); *Tractatus XX*, On Lines Positioned Around Circles (*De Lineis Circulo Circumpositis*); *Tractatus XXI*, On Logarithmics (*De Logarithmis*); *Tractatus XXII*, Part One, On Contact and Division Concerning the Sphere in General (*De Sphera Contactibus, & Sectionibus in Genere, Pars 1.*), and Part Two, On the Maximum Intersection of the Circle and its Reciprocation (*Pars 2. De Intersectionibus Maximorum Circutonem ad Invicem*), and Part Three, On the Maximum Circular and Minor Spherical Contact and Intersection (*De Maximorum Circulorum & Minorum in Sphera Contactibus & Insectionibus*); *Tractatus XXIV*, On Conic Sections (*De Sectionibus Conicis*); *Tractatus XXV*, On Solid Conic Sections for Plane Surfaces (*De Sectionibus Corporum Conicorum Per Planas Superficies*); *Tractatus XXVI*, On Projection (*De Proiectionibus*), and Part One, On Orthography (*De Orthographia*), and Part Two, On

[118] Guarini, *Euclides*, unpaginated (Regalis Celsitudo).

Stereography (*De Stereographia*, Pars 2.); *Tractatus XXVII*, Trigonometry (*Trigonometria*), and Part One, On the Solution of Triangular Planes (*De Triangulis Planis Solvendis*), and Part Two, On the Solution of Spherical Triangles (*De Triangulis Sphaericis Solvendis*); *Tractatus XXVIII*, On the Progression of Surfaces (*De Progressione Superficiem*); *Tractatus XXIX*, Rectilinear Geodesic Planes (*Geodaesia Rectilineorum Planorum*); *Tractatus XXX*, On Curvilinear Transformation (*De Transformatione Curvilineorum*); *Tractatus XXXI*, The Transformation of Surfaces Surrounding Bodies (*De Transformatione Superficierum Corpora Circundantium*); *Tractatus XXXII*, On Solid Surfaces in Reductive Planes (*De Superficiebus Corporum in Planum Redigendis*); *Tractatus XXXIII*, On Inscription and Circumscription of Solids (*De Inscriptione, et Circumscriptione Solidorum*); *Tractatus XXXIV*, Part One, On Solid Enclosed Plane Surfaces (*De Solidis Planis Superficiebus Contentis*), and Part Two, On Enclosed Solid Curvilinear Surfaces (*De Solidis Curvis Superficiebus Contentis*); *Tractatus XXXV*, On the Conjunction of Solid Bodies (*De Corporum Comparatione*).

Guarini's preface (*Benevolo Lectori*) begins, like most of Guarini's treatises, by stating the unequivocal importance of light. All that exists is mathematical and of this light, brought into being from a great and luminous font (*quod ea omnia, quae mathematicas luces, & evidentias in unicum lucis fontem*).[119] From this font, light surrounds the geometrical form of the sphere (*mathematica rerum exordia ex omni parte rotunda, & contornata exiberem*).[120] Guarini references his previous publication, the *Placita*, stating that this work brought him over the threshold of knowledge (*à limine incespitavit*), while shortly thereafter in 1667, his colleague, the Theatine philosopher Ioannes Bonifacius Bagatta (Giovanni Bonifacio Bagatta, 1649–1702), published the *Cursus Philosophicus*.

Bagatta's publication includes an extensive analysis of Aristotelian syllogistics, including a commentary on Guarini's ideas concerning the Categories (*praedicamenta*), a form of grammatical predication which Guarini uses as a form of logic, demonstrating the structural relationship and delineation between physical species. As Guarini states in the *Euclides*:

> The division of these ten categories [*praedicamenta*] created after the Aristotlelian model joins together that which it delivers, and determines how to proceed well, and adequately. [*sic*] In truth, the Categories are called by name as substance [*substantia*], and occurrence [*accidens*]…Form, material, and substance are not distinct entities from matter (and indeed the actual intrinsic and substantial limit of the same material, of which matter is in such a manner modified, and affected, and its limit constituted according to its determined physical species).[121]

[119] Guarini, *Euclides*, (unpaginated).; Ibid., "*Ideoq; cum tota Mathematica, sit alligata in unumq; corpus naturali lege devincta…*"
[120] Ibid.
[121] Ibid. "*Divisionis entis in decem prædicamenta potiùs per modum exempli ab Aristotele suisse traditam; quam quod existimaverit ea esse bonam, & adæquantam. Quæ verò & ceriè prædicamenta appellantur sunt substantia & accidens…Formam materialem substantialem non esse entitatem distinctam à materia (sed esse actualem terminum substantialem intrinsicum eiusdem materiæ, à quo materia taliter modificata, & affecta, & terminata consituitur in determinata phisica specie.)*"

Bagatta elucidates Guarini's idea that all matter is of the same substance, whose categories (*praedicamenta*) change according to their occurrence (*accidens*). Applying the Aristotelian Categories to architecture, form, geometry and light may be thought of as different modifications or physical species of the same essential substance. Light is the generative element; its spatial extension is delineated by geometry; in turn, Guarini as mathematician and architect calculates these dimensions, and therefore, applies them to the art of building. Refuting Bagatta, Guarini's theory on the *praedicamenta* defends the pure potentiality of form (*forma esse pura potentiam*), pointing to the creation of matter from nothing.[122] He denounces Bagatta's position on theological grounds (*terra autem inanis et vacua et tenebrae*, Gen. 1:2), claiming that his theory is scripturally extemporaneous and may, therefore, be deceptive to his reader (*vel quod scriptorum meorum, quos extemporaneos, & subletos eccepit alique fortè positione delusus*).[123]

The relevance of Guarini's diatribe against Bagatta in the preface to the *Euclides* evinces the fundamental importance of light in the creation of form and substance, geometry and architecture. Light is form, the substance of creation. God creates light (*fiat lux, et facta est lux*), and the light creates form by dividing it from the darkness (*divisit lucem ac tenebras*, Gen., 1:3–4).[124] The refutation is also a necessary adherence to the orthodoxy (*orthodoxae religioni*) that is confirmed by the eight members of the clergy that state their approval in the *Imprimatur*.[125]

The *Praeliminaris* of *Tractatus I* begins by establishing a system of mathematical logic in which the genus, or origin of quanitity, may be categorically distinguished from its species (*in quo constitat conceptus quantitatis in genere, & in quot species secernatur*). Guarini references his own theory in *Disputatio XV*, *De Quantitate* of the *Placita Philosophica*, in which he states the origin of quantity are entities which possess the power to act or to multiply.[126] This categorical logic is predicated upon the idea that all mathematics comes from a single source and, in succession, may be understood in all its infinite multiplicity. The source of mathematics is "brought forth in unity as a font of great light;" the "conceptual basis of mathematics is to bind this unity."[127]

The *Praeliminares*, in many ways, reiterates Guarini's defense stated in the preface against Bagatta, providing detail into the essential nature of quantity in the context of potential (*potentia*), action (*actu*), mass (*molis*) number (*numeri*), time (*temporis*), movement (*motus*), virtue (*virtutis*) and weight (*ponderis*).[128] Guarini relates *accidens* (defined as in-

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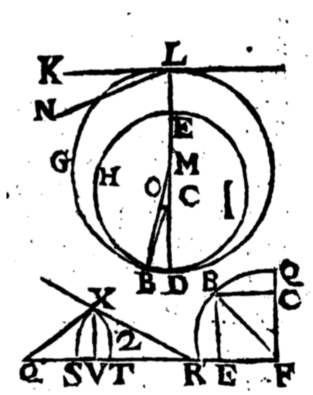
[122] Ioannes Bonifacio Bagatta, *Cursus Philosophicus* (Veronae: Apud Andream de Rubeis, 1667), 24, 73–99. "*…si agens naturale non haberet virtutem producendi ex nihilo*."
[123] Guarini, *Euclides*, unpaginated.
[124] Gryson ed., *Biblia Sacra: Iuxta Vulgatum*, 14.
[125] Guarini, *Euclides*, unpaginated. The members of the clergy who signed the *Imprimatur* are as follows: Fr. Franciscus de Malines (Jesuit), Fr. Petrus Martyr Rubeus (Dominican), Fr. Thomas Camottus (Dominican), Bartolomeus Torinus (Chancellor of Turin), Dr. Amadeus Romagnanus (Theatine), Dr. Carolus Salvaticus, Dr. Gaetanus Garimbertus Præpositus Generalis (Theatine), Dr. Antonius Maria (remains undisclosed).
[126] Guarini, *Euclides*, 1. "*Hanc questionem disfusius agitavi in nostris placitis philosophicis dis. 15. pag. 119 ex qua disputatione liceat aliqua, quæ magnis ad Mathematicum faciunt, híc delibare; ut deinde de evidentiùs ipsa quantitatis essentia sese in apertum prodat.*"; Guarini, *Placita*, 119. "*Quantitas in genere, est capacitas quaedam en titias ad partes habendas, seu actu, vel potentiâ multiplicabiles…*"
[127] Ibid., unpaginated. "*Ideoq; cum tota Mathematica, sit alligata in unumq; corpus naturali lege devincta…*"
[128] Ibid.

cidental or a coincidence) to an extension of the core foundation (*subiecto*), which accommodates the foundational mass of the quantity which it constitutes (*accidens in subiecto extensum, & tunc cum se accomodet subiecto eandem constituit cum eo quantitatem*).[129]

Expensio I of the *Praeliminares* begins by stating the metaphysical importance of mathematics (*metaphysicas cognovisse*).[130] However, Guarini's theory of quantification is architectural in a most fundamental, structural and pragmatic manner. The brilliance of these two aspects of mathematics expresses and, in tandem, demonstrates the purposiveness of theology and metaphysics within the practical framework of measurement (as in the *Modo de Misurare le Fabbriche*), the art of building (*edifizio*), and stonecutting (*stereometria*). The concept of the core foundation (*subiectum*) pertains to the fondament of a building itself, which physically upholds its mass and its weight, which is lifted from ground up through potential, action, and virtue (*macchinaria*) and connected to the universe through number, time and movement (*orologia*, *gnomonica*). The *subiectum* is also an ontological concept, representing the fondament, the core of being.

Expensio II elaborates on the concept in the *Praeliminares* concerning the extension of the core, which, in this case, is applied to a center point (*punctis indivisibilis*).[131] The figure provided describes two concentric circles, the perimeter of one set against the other on one side, connected by two radial lines, one meeting at the center point of the smaller circle and one at the larger. These two radii create an axis point and a fulcrum (BDM), causing the movement of the smaller circle around the perimeter of the larger circle (*circum ductis à centro lineis ad omnia puncta circonferentiae circuli maioris, illa necessariò transfirent per tot alia puncta circuli minoris*).[132]



Guarini, *Euclides*, 3.

The lines K and N, as connected to L, create a second axis point, which cause the movement created by the interaction of the fulcrum BDM, bringing the planar dimension of the two concentric circles into the form of a sphere, the centerpoint of which is now L. This is Guarini's answer to the geometry of the indivisible point (*puncta indivisibilia*) because it

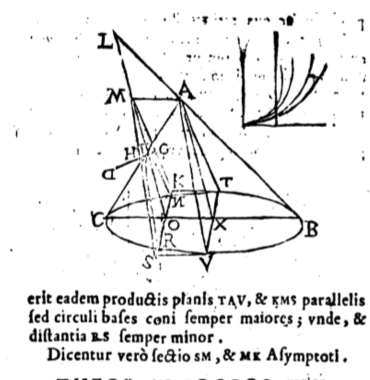
[129] Ibid., 2.
[130] Ibid.
[131] Guarini, *Euclides*, 2.; Euclid, *Elements*, 155. "A point is that which has no part (*Σημεῖόν ἐστιν, οὗ μέρος οὐθέθῖν*)."
[132] Guarini, *Euclides*, 4.

is expandable to an infinite quantity without the separation of form and without the separation of the foundation (*subiecto*) to uphold the mass and weight of the architectural structure.[133]

This geometry demonstrates the even structural distribution of weight in the construction of architecture as well as the symmetry of design, allowing the spherical expansion of a structure, such as a dome, a vault, an arch or the dimensions of any part of a building. However, it can also represent a model of the *axis mundi*, the fulcrum being created by the mass (*molis*) of the smaller circle being pulled (*tractatum*) around the larger circle. This geometric model echoes Guarini's theory in the *Placita Philosophica* of the sun pulling on the moon as it orbits the earth; a theory that prefigured Newton's Theory of Universal Gravitation.[134]

Expensio III enumerates several undiscovered mathematical problems concerning the indivisible point. Guarini begins by dividing the point into two equal parts using a line (*secari lineam novum punctorum in duas partes aequales*).[135] The two points extended into a line rotate concentrically, like the movement of a compass to create a circle (*quòd datis duobus punctis concentricis tot reperirentur puncta*).[136] Diagonal lines extend downward from the point, creating a square (*diagonalis in quadrato effet tot punctorum quod latus; cùm ductis a punctis omnibus laterum parallelis, per omnia diagonalis puncta transfirent*).[137]

The concentric rotation of the indivisible point and its diagonal extensions form the model of a hyperbola and, as the indivisble point rotates, it forms an asymptote, a concentric spiral that tends toward infinity (*quòd hyperbole semper ad asymptotos accedit*).[138] The finitude of the indivisible point is expanded to infinite (or near infinite) quanitity through the model of the hyperbola (*puncta finita in infinitum in quantitate*).[139] Hyperbolic geometry is elaborated further in Guarini's theory of conics (*Tractatus XXIV* and *XXV*).



Guarini, *Euclides*, 417

[133] Ibid., 3. "*Omnis quantitas si augeatur in ifninitu potest quá cumque datam superare, sed angulus contactus circuli cum plano, licet auctus in infinitum.*"; Guarini points out that Galileo also created a theory of the indivisible point as well, but didn't base it on the interaction of two divisions, or concentric circles.
[134] See page 87.; Guarini, *Placita*, 506.
[135] Guarini, *Euclides*, 4.;
[136] Ibid.
[137] Ibid.
[138] Ibid., 5.
[139] Ibid.

Guarini states the rotation of this infinite spiral is applicable to the universal laws of physics, stating that God creates the elements of the universe from the rotation of this infinite spiral. The rotational axis is expressed by declination and degree, as in the measurement of a clock or the movement of the shadow cast by the gnomon on the surface of a sundial.

Indivisible mathematics is based on point, line and surface, while still considering the importance of geospatial coordinates such as latitude and longitude. Point is synonymous with the concept of *loco*; line is synonymous with the *axis mundi* and longitude; surface is synonymous with latitude, as indivisible space extends and approaches infinity (*punctum, cuius pars nulla, linea, quae partes habet secundùm longitudinem tantùm. Superficies, quae partes obtinet secundùm longitudinem, & latitudinem*).[140] As in classical mechanics, the rotation of the indivisible point creates mass (*molis*), as the surfaces which surround the point are not tangential but penetrate the center within it, expanding the point (*si superficies partes enumaret, illa non effet ultimum molis; nec proprie tangeretur; sed penetraretur: cum illud, quod tangeretur, non effet exterius; sed quid internum*).[141]

The theory of indivisible space concludes by discussing the relationship of isoperimetric planes and corporeal bodies (*planities, & à planis ad corpora*) extending forth at every conceivable rectilinear angle (*omnibus angulis rectis*).[142] *Tractatus I* of the *Euclides* sets forth a foundation for Guarini's intricate demonstration of the mathematical relationship between physics (*macchinaria*) and spatial dimension (*gnomonica*) that is directly applicable to architecture (*edifizio*) and to the Church of San Lorenzo.

The *Preliminares* of *Tractatus II* defines the essence of distinct quantities (*De eßentia quantitatis discretae*). Guarini states the essence of unified quantity is dependent on a cognitive understanding of each separate quantity (*dependant à quantitatis discretae cognitione*).[143] The unity of numbers exists in the intellect (*intellectus omnis unitas numeralis*); this foundation upholds their unity as distinct entities and as a unified whole. Each individual number corresponds to every other, and posseses the unity of the whole in their individuation (*unitatem individualem possideret*).[144] Unity is the principle of distinct quanitities (*unitas, quae est principium quantitatis discretae*). Each number, according to its foundation (*subiectum*), brings to fruition additional unity, which creates multiplicity through a coincidence with other unified numbers (*accidens superadditú*).[145] *Tractatus II* describes a brief system of logic, which, according to Guarini, is a simple operation of the

[140] Ibid., 9.
[141] Ibid., 10.; Isaac Newton, *Philosophiæ Naturalis Principia Mathematica* (Londini: Josephi Streater, 1687), 35. Newton's *Principia* begins to describe the relationship between quantity and indivisibility, the interpenetration of the indivisible point, and between mass and the contiguity of expansion. "*Obiecto est, quod quantitatum evanescentium nulla sit ultima proportio; quippe quæ, antequam evanuerunt, non est ultima, ubi evanerunt, nulla est. Sed & eodem argumento æque contendi posset nullam esse corporis ad certum locum pergentis velocitatem ultimam. Hanc enim, antequam corpus attingit locum, non esse ultimam, ubi attigit, nullam esse. Et responsio facilis est. Per velocitatem ultimam intelligi eam, qua corpus movetur neq; antequam attingit locum ultimum & motus cessat, neq; postea, sed tum cum attingit, id est illam ipsam velocitatem quacum corpus attingit locum ultimum & motus cessat.*"
[142] Guarini, *Euclides*, 12.
[143] Ibid., 13.
[144] Ibid.
[145] Ibid., 14–15.

intellect (*licet operationes intellectus, ut simpliciter tales, sint ad placitum*) with which to speculate on the nature of mathematics.[146]

Tractatus III, On Mathematics and the Will (*De Mathematica eiusque Affectionibus*), first discusses the goal of mathematics, the meaning of which for each person is abstract (*de obiecto mathematicae eiusq; abstractione*).[147] In *Expensio I*, Guarini states that mathematics is knowledge as one may see fit (*quaelibet scientia*) that may serve the purpose of logic, the applied arts or any formal function. While mathematics in medicine is concerned with the animal body, physics is concerned with the body of nature. Mathematics, as applied to theology, speculates the nature of God to recognize luminous mysteries and revelations (*cognoscibilis lumine revelato medio discursu*).[148] All mathematical knowledge is an essential form of inquiry; the specific type is dependent on the predilection of the individual (*quod omnia scientia rei speculetur essentiam: quae à particularibus, & individuis praescendit*).[149]

Mathematical mensuration is based on geometry in three dimensions: latitude, longitude and immensity (*enim trinam dimensionem longitudinem, latitudinem, & profunditatem*). According to these three constituents (*que sunt dimensiones ens quantum constituents*), the mensuration of geometrical space adheres to the principles of the *axis mundi*. From these constituents, the cone, the cylinder and the sphere are formed, as well as number, time and the intensity of light (*Agit de conis, cylindris, sphaeris. De numeris, de tempore, de luminis intensione*).[150] There is a potentially infinite division of numbers, as all mathematical figures are inscribed within the circle, within which hyperbola and asymptote advance toward infinity (*hyperbolem ad asymptotum accedere in infinitum*).[151]

Expensio II begins by defining what Guarini calls "*De Machematica*," a way of emphasizing that the mathematics means nothing according to principle alone but must be based on evidence. Without this, nothing in mathematics is tangible, applicable, or definable.[152] This concept applies to optical astronomy, the celestial sphere, physiomathematics, and problems involving fluidity of movement in planetary physics (*quatenus verò ex fluiditate motus planetarú*).[153]

Mathematics is divided into three parts: universal, cosmic and microcosmic (*mathematica in tres partes dividi potest in mathematicam, universalem, cosmicam, & microcosmicam*).[154] The universality of mathematics is abstracted into parts: the human being and the cosmos. As in the anthropic measurements of Vitruvius' *Ten Books* and Leonardo da Vinci's *Vitruvian Man*, Guarini expresses the harmonious relationship between the proportion of the human body and the universe (*quae considerat mundum eiusque proportiones*

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[146] Ibid., 20.
[147] Ibid., 21.
[148] Ibid.
[149] Ibid.
[150] Ibid., 21.
[151] Ibid., 22.
[152] Ibid. "*Mathematice nome derivat à Greco nomine, quod Latino deprumtù significat doctriná: seu disciplinam, eo quia verè doceat; quòd nihil, nisi per ostensionem, ut plurimum, affirmet, & nihil, nisi, aut per se evidens, aut probatum ad arguendum pro principijs assumat. Aliæ verò scientiæ pro maxima sui parte potiùs probabiles sunt, quam evidentes, unde potest deffiniri.*"
[153] Ibid.
[154] Ibid., 23.

dicitur cosmica; quae hominem microcosmica appellar potest) and points to optical vision as the core of this relationship.[155]

Guarini defends the importance of the *Elements* as a theorem (*theoremata*) and not simply a set of problems (*problemata*), because it accomplishes something very universal; its geometrical propositions point to the very source and origin of mathematics (*plurimam propositionum fons, & origo*).[156] The practical, material function of the *Elements* is dependent upon the knowledge of this origin; however, divided or multiplied, they must be thought of and function together, as one unified element (*ut ipsis singulis omnia elementa*).[157]

Guarini, like Aristotle, states that the cognitive understanding of mathematics must be a preexistent cognition (*omnis cognitio sit ex praexistenti cognitione*). The principle of mathematics thus remains clear and straightforward, making its propositions impossible to deny. Mathematical truth, from its very principle, is undeniable; if this principle is denied, this may be proven through the impossibility of ostensible demonstration (*protinùs per reductionem ad impossibile ostendat*).[158]

Definition (*De Definitionibus*) is the truth, the nature of things, the essence of these things which is explained by its name, which of itself is an explanation of its definition.[159] Postulation (*De Postulatis*), is quasi-axiomatic; it is the operative function of speculation (*solùm speculativa; illa verò operativa*).[160] Theorem (*Quid sit Theorema*) must endure the rigors of quantitative evidence (*passionis quantitativae evidens*). Without evidence, everything is pure speculation.[161]

Guarini defines porism (*Quid sit Porisma*) as the name of a controversial and ancient subject; one, which Pappus of Alexandria (c. 290–c. 350 AD) defines as threefold: something that is neither a problem or a theorem (*species omnes neque problematum, neque theorematum*); something that lies halfway between that which exists as a form and something possessed by nature (*sed mediam quandam inter haec theorematum*); and that which is fact because the complex geometry that generates the problem itself, is true of the theorem (*quo factum est ut ex multis geometris a ij quidem ex genere esse problemata, alù vero theoremata opinati sint*).[162] Porisms are problems which approach the unsolvable due to the difficult and weighty analysis required to comprehend them and are related to the

[155] Ibid.
[156] Ibid.
[157] Ibid.
[158] Ibid.
[159] Ibid., 24. "*Definitiones apud Mathematicos verè naturam rei non explicant ex eorum intentione; tùm essentiam rei explicare; sed tantùm nomen exponere sit apud ipsos in definitionibus constitutum…*"
[160] Ibid.
[161] Ibid. "*…quia in purâ speculatione sistit, & nihil efficit.*"
[162] Ibid., 24.; Euclid, *Elements, vol. 1*, 10. The porisms are controversial because Euclid's books concerning them, of which there are three, are lost. The primary source of information about them comes to us from Pappus, in the preface to his eight major works known as the *Treasury of Analysis* (*τοπος ἀναλυόμενος*). The third premise which Guarini relates to us from Pappus (*quo factum est ut ex multis geometris a ij quidem ex genere esse problemata, alù vero theoremata opinati sint*) is related because of the nature of its hypothesis, and for this reason falls short of a locus-theorem. Guarini states that the geometry itself generates the theorem and is therefore precognitive, which Guarini states is behind the principle of mathematics (*cognitio sit ex præxistenti cognitione*, see pg. 113).

concept of *aporia* (*ἀπορία*), a philosophical impasse, of which there is seemingly no conceivable solution.[163]

Guarini defines the Greek derivation of the word *ζήτημα* (*Quid sit Zetema*), as a kind of philosophical search, or investigation, as a solution, an inscription which prefigures its own algebraic operation. Zetema are solved within their own operation, and like porisms, cannot properly be called problems or theorems.[164]

Guarini defines the lemma (*Quid sit Lemma*) as a necessary form of mathematical demonstration for certain fundamental propositions which must be tested beyond institutional assumptions (*Lemma itaque est demonstratio, seu constructio, quae necessariò ad demonstrandum aliam propositionem principalem, & ad rem spectantem praeter institutum assumitur*).[165] The term *lemma* (*λημμα*) may be defined as epigram (*ἐπίγραμμα*): an inscription. In Euclidean geometry, this involves the comparative calculation of ratios and geometric angles or sides to form correlations through syllogistic logic.[166]

The lemma is a necessary constituent of measurement concerning the cosmology of a building, such as San Lorenzo, because of the inherent nature of measurement and the relativity of size. It is also the declination of angle and the measurement of distance that is assumed through the use of an astrolabe or spherical astrolabe (celestial sphere), of which the dome of San Lorenzo appears to represent a model.

Proposition (*Quid sit Propositio*) gives name to that which is generative that is furthered by porisms, problems and assembled theorems (*propositio est nomen quoddam genericum; quod tùm porismati, tùm problemati, tùm theoremati convenit*).[167] Analysis (*Quid sit Analysis*) is that which explicates the problem, while synthesis (*et Synthesis*) verifies and accepts it, transmitting it to the mode of operation.

Tractatus IV (*In Primum Librum Elementorum*) discusses specific problems within the first book of Euclid's *Elements*. *Expensio I* (*De Triangulis Constituendis*) establishes the mathematics of the triangle. Guarini states that the triangle is the first geometric figure after the circle, within which everything is inscribed (*ideò primus limes in triangula ingreditur*).[168] The triangle is the first rectilinear, structural geometric form, a shape caused by the mitosis of the circle into two, so that they overlap, creating the three-sided shape to

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[163] Ibid., 24. "*Porisma à multis sic intelligitur ut ar fuiosa collectio si ad Analysim graviorum, seu difficilorum problematum, & generum in comprehensibilem multitudine præbente ipsorum natura.*"

[164] Ibid., 25. "*Zetema est titulus; quem Algebrici suis operationibus præfigunt: cùm enim ea, quæ Algebra docet non demonstrentur; sed in ipsa operatione nota, & evidentia avadant; propter hoc, nec problema, nec Theorema appellare potuerunt: unde quam medio nomine Zetema appellaurunt.*"

[165] Ibid.

[166] Euclid, *Elements, vol. 2*, 242–3. "…proof of a lemma to the effect that if two similar figures are also equal, any pair of corresponding sides are equal. To supply this lemmais one alternative; another is to prove, as a preliminary proposition, a much more general theorem, viz. that, if the duplicate ratios of two ratios are equal, the two ratios are themselves equal."

[167] Guarini, *Euclides*, 25.

[168] Ibid., 33. "*Unde puto gravia per se, & difficilia primo ingressu esse Elementa; ut contra ius faciat, & æquitatem, illum, qui insuper ad augendam fascem, aliena vocet in Elementa, & ex alijs principijs dependentia, & ideò obscurissima, & altioris ordinis, ut tenebras offundat clarissimis, proponat.*"; Guarini's theory of the triangle resembles the theory of Plato's *Timaeus*, in which the sphere is the perfect form, while the physical world is made of polygons—all of which are constructed from equilateral triangles. See Hendrix, *Architectural Forms*, 65.; Ludovico Nogarola trans., *Timaei Locri, Philosophi Pithagorei de Mundi Anima, & Natura Libellus* (Venice: Hieronymum, 1555), 8. "*Nam in eo quod Mundus est globosus, ipsi omni ex parte sui similis existit, atque omnes alias eiusdem generis figuras suo coplexu potest continere.*"; Ibid., 7. "*Materiam vero dixit effigie matrem, nutricem, & quæ tertiam generare naturam poßit.*"

form between them. The extension of a line between the center of each circle, extended upward equilaterally on both sides to the point where the outer edges of each circle meet, creates the equilateral triangle.[169]

The triangle is the foundation, the fondament, the universal structure upon which all others are built, for its base is upheld equilaterally and brought to a point by its two other angles (*hinc est universaliter, quòd si detur triangulum habens duo crura innixia eidem basi*).[170] Guarini's theory of the triangle involves the shadow cast by the equilateral triangle in a circular motion and involving the potentiality of semidiametrical expansion through the propagation of the circles which overlap, creating their formation (*ed ideò noluit id inter postulata exquirere, tanquam concedibile; cùm hac proprietatem aequalium voluerit demonstrare; quod scilicet potentiâ sint eiusdem circuli semidiametri*).[171] This Euclidean demonstration relates to the function of the gnomon, which is triangular and which casts a shadow upon the hour of the day and the time of the year that is inscribed upon the dial.[172]

Tractatus V pertains to the second book of the *Elements* and the generative equipotentiality of lines (*In Secundum Librum Euclidis de aequipotentia linearum*). The equipotentiality of a parallelogram is discussed in light of the science of shadow projection and gnomonics, where a diameter bisects the parallelogram, forming two opposing triangles, reflecting light and dark like a mirror onto one another.[173]

The potential of lines extends to the use of triangular divisions to allow the connection between two rectangles at various declinations (*De potentiâ laterum triangulorum*). When a line is extended from the middle of a rectangle that is parallel with its side, and lines are drawn to meet it at a point, this forms a triangle from which may generate two other rectangles connected to its vertices (*in triangulis rectangulis quadratum, quod à latere rectum angulum substendente describitur, æquale est duobus quadratis, quæ à lateribus angulum rectum continentibus describintur*).[174] This theorem is expanded using obtuse (*amblygonijs*) and acute (*oxigono*) triangles, as well as the creation of the trapezoid, using a curvilinear extension between the two opposing points of rectangles which are extended from the triangle.[175]

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[169] Guarini, *Euclides*, 33. "*Prob. Linea C B est æquales lineæ B A; ut ducte à centro B ad punctum circumferentiæ A, & C. Linea quoq; altera A C est æqualis eidem A B, ob eiusdem rationem, quod ductæ sint à centro A ad puncta circuferentie C, & B; Ergo cùm lineæ tertiæ A B, duo crura A C, & C B sin æqualia, erunt & invicem æqualia*."; The same figure appears in Guarini, *Architettura Civile*, Lastra I, Tratt. I, fig. 19.
[170] Guarini, *Euclides*, 34.
[171] Ibid., 35.
[172] Thomas Da Costa Kaufmann, "The Perspective of Shadows: The History and Theory of Shadow Projection" in *The Journal of the Warburg and Courtauld Institutes* 38 (1975): 263. "By measuring the length of shadows cast by gnomons and reasoning from the geometry of similar triangles, an altimetric procedure employed by Euclid among others and said to date all the way back to Thales, astronomers attempted to determine the distance of the sun from the earth."; Kircher, *Ars Magna Lucis*, 144. "*Ars Gnomonica es certa, & demonstrativa motuum cœlestium in quolibet plano, aut superficie per gnomonis umbram repræsentandorum facultas.*"
[173] Guarini, *Euclides*, 54. "*In omni parallelogramo unumquodque eorum, qua circa diametrum sunt parallelogrammorum, cum duobus complimentis, Gnomon vocetur. Dicit in parallelogramo AGCM, unum parallelogrammum diametrum AB ambiens, V.g. nigrum cum duobus complimentis albis DC, & DG vocandum esse Gnomonen; Vel nigerrimum minus, cum duobus complimentis ijsdem Gnomonem appellari.*"
[174] Ibid., 58.
[175] Ibid., 61.

Tractatus VI pertains to the third book of the *Elements*, which focuses on the circle, the figure which is the origin of all geometry. The circle is the generative principle of all integral and constructed shapes, including the triangle, square, as well as curvilinear lines, which generate the formation of hyperbolae, parabolae, ellipses, spheres and conics.[176] Several demonstrations commence, which all generate from the point at the center of the circle and how it may be extended in various dimensions to create simulacra of the circle, which then extends rectilinearity forth, forming the potentiality of other forms (hyperbolic, parabolic, etc.).

The optical basis for such linear extensions is the creation of convexity and parallax by bending the periphery of the circle to reflect upon itself, like a lens (*si extra circulum sumatur punctum quodpiam, & ab eo ducantur rectæ, una per centrum transiens, reliquae aliae in causam peripheriam, vel convexam*).[177] This concavity is created by the collapse of the peripheral concavity due to the extension outward from the center of the circle (*extra circulum, & ex eo in concavum peripheriam cadens recta transeat per centrum*).[178]

Tractatus VII pertains to Book Four of the *Elements* and to the inscription and circumscription of the circle (*In Librum quartum Elementorum. De inscriptione & circumscriptione figurarum in circulo*). As a progression from *Tractatus VI*, Book Four forms a comparison between the circle and other solid figures, thus developing the figure of the circle into a solid Archimidean sphere.[179] The extension of a line within the figure, a triangle or rectilinear form, multiplies the form of the circle by shifting its axis point. Differently than the previous demonstration, the shifting of the axis connects the two circles, which double to form a solid (*insistens erunt duplicia*).[180]

The duplication of geometric forms within the circle is also a reference to Clavius, in which he theorizes on the amount of multilateral, equilateral and equiangular figures that may be repeated within the form of the circle (*reperire figuras multilateras, aequilateras, & equiangulas*).[181] The inside periphery of the circle is divided into fifteen angles (*quindecagoni*), which are divided into the pentagon and the triangle, intersecting at various equidistant arclengths (*probatur tres arcus, quibus anguli trianguli insistunt, vel quibus latera equalia subtenduntur*).[182]

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[176] Guarini, *Euclid*, 63. "*Egit in duobus primus Libris Euclides de primo genere superficierum; nimirum de rectilineis, & non quidem de omnibus; sed solùm de præcipuis, & quæ alias figuras planas integrant, & componunt, ut sunt triangula, & quadrangula, nimirum, ut eas solùm, quæ erant elementares attingeret: In hoc verò tertio Libro agit de circulis, quæ figura est origo, & principiùm omnium linearum flexarum, puta Hyperbolæ, Parabolæ, Ellipsis, aliarumque similium, ut sicuti rectilineorum Elementa, & flexorum quoque doceat, his enim principijs ferè omnia fundatur, quæ tum de sphera, tum de sectionibus conicis ostendentur.*"

[177] Ibid., 72.

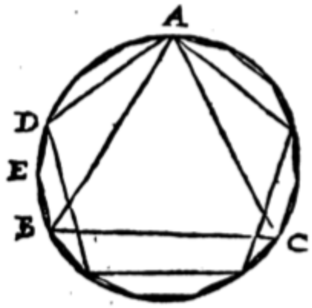
[178] Ibid.

[179] Ibid., 83. "*Liber quartus agit de descriptione figurarum respectivè ad circulum; licet enim triangula, & quadrata possit sine circulo describi, commodiùs tamen cum reliquis figuris, aut intra circulum, aut circa circulum describuntur. Usus verò huius Libri pernecessarius est, tum solidis in sphæra inscribendis, & circumscribendis, tum ad comparationem externæ figuræ solidæ, cum interna, ex qua Archimedes soliditatem sphæræ adivenit, tum ad lineas, chordasque arcuum inveniendas, & tandem ad Militares delinationes fortalitorum.*" Stated at the end of the previous note, the reference to Archimedes pertains to the use of spherical geometry for military fortification, connecting Guarini's Euclidean knowledge to that of the *Trattato di Fortificatione*.; Ibid. "*Antequam propositiones ipsas aggrediamur aliqua principia, definitionesque ad hunc librum, spetialiter spectantes oportet agnoscere; istæ verò sunt.*"

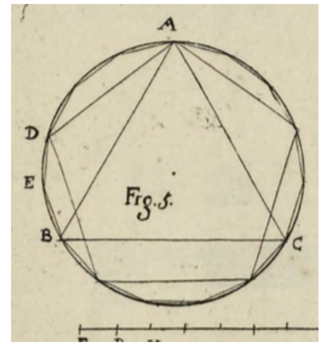
[180] Ibid., 87.

[181] Ibid., 91.

[182] Ibid.



Guarini, *Euclides*, 91



Guarini, *Euclides*, Lastra 3, Trat. 2, Fig. 5

Tractatus VIII pertains to simple arithmetic and the general integration of numbers (*Arithmetica Simplex, & Generalis integrorum numerorum*). The corresponding relationship between arithmetic and geometry, in which the inscription of geometric forms is equal in proportion, causes any inequality to be superseded (*iam aliam provinciam aggreditur, & proportionem inaequalitas praecipuè considerare, vel saltem iam ab aequalitate praescindere incipit*).[183] In principle, this correspondence is maintained through the compositional unification of numerical multitude (*numerus est ex unitatibus composita multitudo*). Guarini's unification of numbers is based on equivalents; number corresponds with measurement or value (*unde unitas omniu numerorum erit communis mensura, quâ omnes mensurari poterunt*), so that the sum of greater and lesser numbers are the division of their sum (*omnis verò pars assumit nomen ab eo numero, per quem multiplicata metitur maiorem, ut 6. dicitur tertia pars numeri 18. quia 6. mulciplicatus per 3. metitur numerum 18*).[184] These numbers correspond as equal because their sum and their parts are equal and, thus, cancel each other.

Guarini differentiates between this form of corresponding arithmetic and numbers which are non-equivalents (*partes autem; cùm non metitur*). If the delineations of measurement vary from their quantitative value, then the numbers do not divide into nothing (*metitur*), thus generating architectural space. This strange arithmetical relationship, which according to 'normal' calculation would be illogical, is essential to the generation of Euclidean geometrical space and, therefore, to architecture. The non-equivalent relationship of numbers creates the propagation of space, the expansion of the indivisible point (*punctum indivisibilia*).

This relationship is evident within many of the architectural drawings and treatises of the ancient past through the Baroque period, including Guarini's *Civile*, in which he states that proportion is a correspondence between two quantities which are commensurate with another (*proporzione è una corrispondenza de due quantità nel commensurarsi l'una coll'altra*).[185] The two quantities are commensurate only because they can be measured against a third, creating a spatial dimension. Referencing the Milanese architect Carlo

[183] Ibid., 92.
[184] Ibid.
[185] Guarini, *Civile*, 25.

Cesare Osio (b. 1612), Guarini states that the creation of architectural symmetry and proportion requires an understanding of space that exists between two quantities.[186]

Osio's treatise, also entitled *Architettura Civile* (1661), describes two arithmetical relationships involving proportion: one that is rational and another that is irrational (*ogni proportione primieramente è ò rationale, ò irrationale*).[187] According to Osio's theory of proportion, rational proportion is combined to create their numerical equivalent. However, there is dimensional space created through the juxtaposition of unequal numerical values (*proportione poi di disuguaglianza è quella, che passa trà due quantità disuguali trà loro, come per esempio trà il 20. & il 10., trà 1 '8 e il 40., ò pure trà la linea di sei palmi, e quella di due, e simili*).[188] This theory of proportion allows for the articulation of spatial dimension used in architecture (*la proportione superarticolare*), including more complex quadratic geometries, such as the squaring of the circle or, as Osio refers to it, the proportion of the diameter of the square (*la proportione del diametro del quadrato*).[189] As Guarini also states, the calculation of two numbers in mutual and relational measurement exists in inequality (*ratio est duorum numerorum mutua in ratione mensuratis, & mensurati relatio*), which exists as itself, divided (*alium faltem per unitates, quae in ipso sunt, metitur*).[190]

Tractatus IX, Pars Prima, pertains to the fifth book of the *Elements* (*In Librum V Euclidis*) and to the idea of proportion (*De Proportionum Notione*). *Expensio I*, On Calculation (*Quid sit Ratio*) states that calculation involves the relationship of quantities. Calculation, therefore, is the relationship of parts to the whole, of everything which exists as proportionate that is beyond the function of its prior origin and its total proven definition (*cum ergo ratio en relatione partis, & totius consistat, & commensurationis, & operae praetium est priùs partis, & totius definitionem declarare*).[191]

The third clause in the definition (*operae praetium est priùs partis*) is the functional quality of a lemma, based on the precognitive knowledge of a definition, which allows one the geometrical expansion of the idea through the expansion of proportion. This procedure is based on Guarini's next definition, which examines proportion through minor and major magnitude, in which doubling changes parts from few to multitudinous (*duplex ex pars alia Aliquota, alia Aliquanta*). Guarini references Aristotle's *Metaphysics*, stating that measurement is synonymous with generation, as the magnitude of measurement is synonymous with magnitude, longitudinal measurement is synonymous with longitude, as is latitudinal measurement with latitude, the voice with the voice, gravitation with gravity.[192] Therefore, the functionality of proportion is according to the generation of magnitude, longitude, etc.; all geometric forms in mathematics and in architecture are generative, while

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[186] Ibid. "*Dovendo l'Architetto impiegarsi nelle simmetrie, e propozioni, è necessario, che delle medesime n' abbia qualche cognizione: di queste ne tratta Carlo Cesare Osio nelle sue precognizioni più necessarie nell'Architettura pag. 31., e presuppone senza la medesime non potere l'Architetto procedere giustamente nelle sue operazioni.*"
[187] Carlo Cesare Osio, *Architettura Civile: Demostrativamente Proportionata et Accresciuta di Nuove Regole* (Milano: Archiepiscopale, 1661), 31–2.
[188] Ibid., 32.
[189] Ibid.
[190] Guarini, *Euclides*, 94.
[191] Ibid., 106.
[192] Ibid. "…*mensura eiusdem generis est, magnitudinem namque magnitudo, & secundum unumquodque longitudinis longitudo, latitudinis latitudo, vocum vox, gravitatis gravitas; & c.*"

their property of measurement is merely relative. Their generation is not discovered because of minor and major quantities or surfaces, but their fundamental calculation is antecendent to the limit of mathematics (*verum fundamentum huius relationis dicitur à mathematicia antecendens terminus verò consequens*).[193]

Guarini states that there is no finite proportion which corresponds with the infinite (*ergo finitum infinito nulla proportione conformatur*); therefore, infinity and that which pertains to the infinite is not a proportion (*infiniti ad infinitum nulla est proportio*).[194] One cannot create a greater sum of infinity, but the idea of the infinite may be increased and augmented (*ergo infinitum non potest habere aliud infinitum maius & iedo multiplicatum erit*).[195]

The replication of proportion for composition is made greater according to the magnitude of three, so that it is the first and the middle calculation. As the middle is according to thirds, and thirds to fourths, the first will correctly duplicate the proportion of three by tripling and quadrupling consecutively until the appearance of the limit (*proportio replicata est; cum trium maginitudinum, vel plurium, eadem est ratio prima ad mediam, quae media ad tertiam, & tertiae ad quarta primae enim dicitur duplicata habere proportionem ad tertiam; triplicatam ad quartam, & sic consequtivè donec termini extiterint*).[196] The replication of proportion exists as an architectural principle but also as a principle involved with cartographic and astrographic triangulation and measurement involving gnomonics and spherical astrolabes.

Tractatus IX, *Pars Secunda*, on the fifth book of the *Elements*, pertains to the origin of proportion (*De Proportionibus in Genere*), which Guarini invites us to read as if it is a work of metaphysics in the context of philosophy (*hic tractatus veluti metaphysica apud phylosophos*).[197] *Pars Secunda* is an elaboration of the generative cause of proportion discussed in *Pars Prima*, a presentation of a system of proportion that is unbounded, free and unrestricted (*liber proportiones*), so that the understanding of mathematics becomes a simulacrum of the universe (*similitudines sub tota universalitate animadvertit*).[198]

Proportion and quantification change and multiply, while their calculation remains similitudinous (*proportionibus dissimilitudinem, & tandem de plurium quantitatum ad plures in rationibus similitudine*).[199] This method of proportional calculation is important from an architectural vantagepoint because the method of calculation, or *ratio*, is a core, an axis, a fulcrum around which multiplicity and magnitude are formed. The *ratio* of 1:3 or 1:5 is equivalent, however, delineated by numeration and division. This formation may be antecedent or consequential; however, the importance of this form of proportion is that the method of calculation pertains to magnitude and not static or quantitative distance, creating a sense of infinite or 'ecclesiastical' space within the work of architecture.[200]

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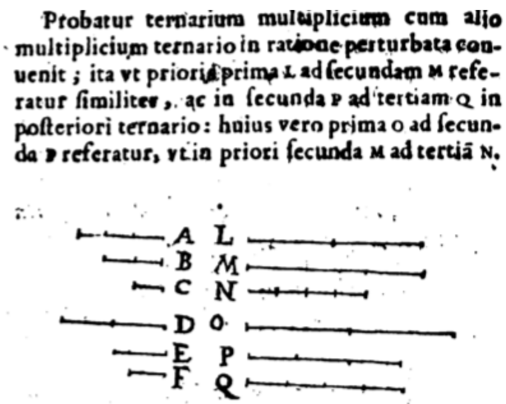
[193] Ibid., 107.
[194] Ibid., 108.
[195] Ibid.
[196] Ibid., 111.
[197] Ibid., 118.
[198] Ibid.
[199] Ibid.
[200] Ibid., 126. "*Si sint magnitudines quotcumque proportionales; quemadmodum se habuerit una antecendentium ad unam concqequentium; ita se habebunt omnes antecedentes ad omnes consequentes.*"


Probatur ternarium multiplicium cum alio multiplicium ternario in ratione perturbata conuenit; ita vt priori prima L ad secundam M referatur similiter, ac in secunda P ad tertiam Q in posteriori ternario: huius vero prima O ad secunda P referatur, vt in priori secunda M ad tertiã N.

Euclides Adactus, 130

Tractatus X pertains to book six of the *Elements* and the proportion of continuous quantity (*de proportionibus quantitatis continuae*). The generation of proportion descends through the diversification of matter, which is particularly useful in numerical calculation and the continuation of quantity.[201] This method of continual quantity develops out of *Tractatus IX*, by delineating between rational and irrational numerical calculation (*quantitatis verò contìnuae duplex est, alia rationalis, alia irrationalis*) and by placing this method of calculation within a framework of geometric forms, such as triangles, parallelograms and their division.[202]

The planar division of these forms also becomes a form of shadow projection as well, which is related to projectional geometry and gnomonics. The projection of the shadow and its form is proportionally equivalent; in gnomonics, the angle of the style is equivalent to the geographic latitude of the sun.

Euclides Adauctus, 140, 141

Tractatus XI, *Pars Prima*, pertains to the eighth book of the *Elements* and to the generation of numerical proportion (*De proportionibus Numerorum in genere*).[203] *Pars Prima* pertains to three principles: the fundamentals of numerical proportion, of mensuration according to ratio, and numerical proportion as demonstrated according to the universality of the generation of proportion presented in Book Five. It is essentially an expansion and elaboration on the equanimity of proportion according to the principles of *ratio*.

Tractatus XI, Pars Secunda, pertains to more specialized principles of numerical proportion in Book Eight of the *Elements*. These principles occur primarily according to the numbers of planes and solids within various geometric forms (*de numeris planis, &*

[201] Ibid., 132.
[202] Ibid.
[203] Ibid., 154.

solidis).[204] The multiplication of planes and solids forms a continuum in which the measurement of planes creates a proportional equanimity with solids but may never be considered of the same species.[205]

Tractatus XI, Pars Tertia also pertains to the ninth book of the *Elements*, which elaborates upon the generation and invention of planes and solids (*De Planorum, Solidorumque generatione, & inventione*) and explains the difference between planes and solids presented in *Pars Secunda*.

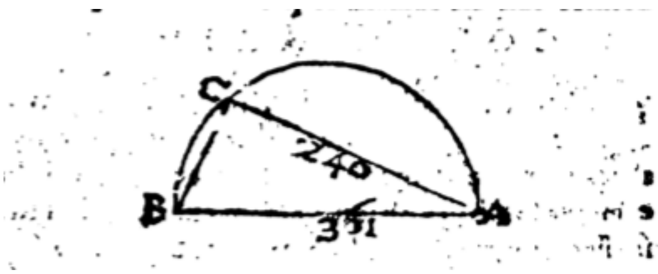
Guarini demonstrates that the multiplication of the square produces the cube (*qui numerus multiplicans alium cubum, vel quadratum efficiat*).[206] The four sides of the square multiplied by the six sides of the cube create the quadratic solid of twenty-four (*numerus compositus 6. multiplicans quemlibet alium numerum 4. faciet alium aliquem puta 24. Dico genitum 24. Eße solidum*).[207] The determination of spatial dimension that this allows is architecturally significant in terms of the science of stereotomy and the measurement of solids in projectional geometry.

Tractatus XII pertains to book ten of the *Elements* and the irrational nature of lines.[208] The irrational nature of lines pertains to a discrepancy between numeration and potentiality of magnitude. Guarini applies this logic to a problem that goes against the theory of longitudinality, which also pertains to gnomonic projection and Guarini's interest in finding the proper site of a building upon the surface of the earth. The measurement of longitude becomes irrational when measured according to quadrature because of this potentiality (*sicut quadrata proportionem non habentia, quam quadratus numerus ad quadratum numerum, nec latera habebunt longitudine commensurabilia*).[209] The incommensurablity of proportionate lines is based on the fundamental problem of limit, which Guarini defines in *Expensio I*, *Prooemium*, of the *Praeparatio ad Logicam* of the *Placita*.[210] This incommensurable nature of limit allows for the calculation of the measurement of lines (*funibus*) to remain open (*patet*), ubounded, infinite.[211]

The invention of rational lines (*de inventione linearum rationalium*) only comes about through *accidens*, the causational interference of other geometric forms. Guarini uses

[204] Ibid., 171.
[205] Ibid., 174.
[206] Ibid., 176.
[207] Ibid., 178.
[208] Ibid., 182.
[209] Ibid., 184.; Euclid, *Elements*, 1. "…the discovery of the irrational is due to the Pythagoreans. The first scholium on Book X. of the *Elements* states that the Pythagoreans were the first to address themselves to the investigation of commensurability, having discovered it by means of their observation of numbers. They discovered, the scholium continues, that not all magnitudes have a common measure. 'They are all called magnitudes measurable by the same measure commensurably, but those which are not subject to the same measure are incommensurable, and again such of these as are measured by some other common measure commensurable with one another, and such measures they referred everything to *different* commensurabilities, but, though they were different, even so (they had proved that) not all magnitudes are commensurable with any. (They showed that) all magnitudes can be rational (*ρητα*) and all irrational (*αλογα*) in a relative sense (*ως προς τι*)….'"
[210] Ibid., 185. "*Si quator magnitudines proportionales fuerint, & fundamentum primæ combinationis suo termino sit commensurabile; fundamentum quoque secundæ combinationis suo termino erit commensurabile, & si è contra fundamentum illud primæ suo termino sit incommensurabile; tale quoque erit fundamentum secundæ combinationis respectu sui termini.*"
[211] Ibid., 186. "*Quæ incommensurabilibus invicem sunt commensurabiles, fune inter se etiam incommensurabiles, quia eadem militat ratio de duabus, aut pluribus, & de una, ut patet.*"

the example of a quadratic form placed within a semicircle, stating that the angles and measurement of the line are found because of the angle created by its coincidence with the edge of the semicircle. While the nature of this tract appears simple, it is a testament to the potentiality of generated forms in which the infinite line is reflected at any dimension, like light through a prism or the shadow created by the bending of light around the surface of the gnomon, reflected onto the plate of the sundial.

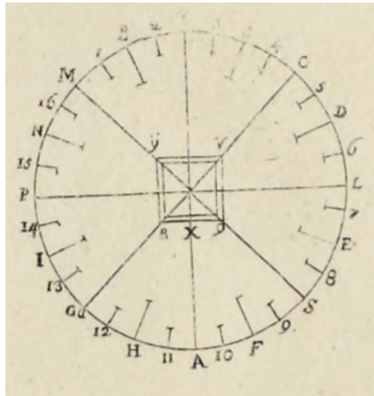


Euclides Adauctus, 188

Tractatus XIII, *Pars Unum*, pertains to proportional numbers (*In Numeris Proportionalibus*). Guarini states that the most finite measurements of proportion may be obtained by using an algorithm (*antequam ipsarum minutarium algorithmum proponamus, necesse est cognoscere ipsarum proportionem, quam hic breviter indicabimus*) created by the interrelation between fractions.[212] When an area is divided into four equal parts, it is divisible in a number of ways (*una erunt numerus fractus*). When the division of the area is into thirds and then into eight equal sections (3:8), the Golden Section is formed (*item si tres aurei secti sint in 8. partes aequales*).[213]

Guarini places the measurement of infinitude against finitude; the harmonious aesthetic quality of the Golden Section is juxtaposed against the *minutiae* of measurement and delineation. While the focus of the *Euclides* is geometric form and measure, a corollary between the finitude of measurement is applied to time and thus to movement, relating once again to gnomonics, light and the passing of the sun. The delineation of time, predicated on 360-degree movement, is produced through the delineation of *minutiae*, the declination of degree, and the demarcation of minutes (*numerus ex mutua multiplicatio denominatoru productus, nempe 360. & minutia summa omnium praedictarum stabit*).[214] This system of demarcation is presented in the *Architettura Civile* as well, a diagram that is applied to *Trattato II, Della Icnografia*, a system of chronological time that Guarini connects to the celestial sphere, and to the art of building.

[212] Ibid., 207.
[213] Ibid.
[214] Ibid., 215–16.



Architettura Civile, Lastra II, Trat. II, Fig. 4

Tractatus XIII, *Pars Secunda*, pertains to numerical proportion which is to be discovered by determining the area of the Golden Section (*De Numeris proportionalibus inveniendis auream regulam proportionum*) by determining two median proportions (*mediam proportionalem*) and by determining its square root (*radicis quadratae*).[215] Guarini states that the principles presented in this tract are absolutely necessary as without them no one is able to make mathematical progress (*tractatus omninò & absolutè necessariùs, sine quo in Mathematicis proficere nemo potest*).[216]

Tractatus XIV, *Pars I*, pertains to numerical proportion (*in proportiones geometrica continua*) and to what Guarini considers the three true forms of proportion which nature has put forth, those being geometry, arithmetic and music (*geometrica, arithmetica, musica, de quarum naturâ agere opus est*).[217] *Tractatus XIV* explains these three principles of proportion by transforming them into a single species.

Tractatus XIV, *Pars Secunda*, pertains to arithmetical proportion (*De proportione Arithmetica*), by connecting geometrical proportion to arithmetical measurement (*ideo post tractationem proportionalitatis geometricae statim arithmeticae discursus subnectendus est*).[218]

Tractatus XIV, *Pars Tertia*, pertains to harmonic proportion (*De Proportione Harmonica*), which occurs when the proportion of geometric forms is between extremes and which is between their differences, when their numbers are divided from their extremes, as in the example of 2 & 6 being proportional with 1 & 3, while 6 & 3 are harmonic at their extremes. Guarini states that harmonic proportion is also related to optics and the power of magnification (*haec autem proportio, licet dicatur harmonica, est tamen potiùs optica*).[219]

A number of other important treatises on harmonic proportion and music were published around the time of Guarini's *Euclides*. Perhaps most notable are *Harmonices Mundi* (Harmony of the World) by Johannes Kepler (1571–1630), *Musurgia Universalis* (Music

[215] Ibid., 216.
[216] Ibid.
[217] Guarini, *Euclides*, 230.
[218] Ibid., *Placita*, 237.
[219] Ibid., 242.

of the Universe) by Athanasius Kircher (1602–1680), and *Tractatus Proportione Harmonica* (Treatise on Harmonic Proportion), by Jacques de Billy (1602–1679).[220]

Tractatus XV pertains to the segmented line and its proportions (*De Linearum, Segmentorumque proportionibus*) and to the amplification of line according to its restricted limits and widths through the understanding of multiple propositions (*verùm linearum amplioribus terminis clauditur speculatio, latiorque admodum est, & quae cognitionem multarum propositionum*).[221]

Guarini explores the multilateral proportion of lines as it may be extended infinitely within the sphere, which he represents diagrammatically with the semicircle (*datis duabus rectis lineis proportiones earum progagare in infinitum*).[222] The relationship between minor and major proportions propagates and increases (*secundùm proportionem minoris ad maiorem crescendo sit propaganda proportio*); the point at the center turns back on itself and is led back in the form of an arc by its many intervals (*rurusque ex puncto C ducto arcu CF intervallo AC*).[223]

This method of geometric propagation holds true in theory to the ancient principles of physics in nature, such as the way that concentric rings are formed by a disturbance upon the surface of water or the propagation of sound waves (*hoc problema antiqui, non nisi organicè solvere potuerunt ob infinitam*).[224] The application of this theory to architecture is important structurally because of the way that space propagates from the center, returning to center (*rurusque*) only to propagate once again with infinite force (*an verò haec continuatio possit verè in infinitum produci infra videbimus, cum de proportionum progressione*).[225] The proportionate relationship of forms within a building that follow this method of harmonics may also be aligned with harmonic geographic and universal proportions, as in the relationship between architecture and gnomonics.

Tractatus XVI, *Pars Prima* pertains to proportional progression (*de progressione proportionali*) and how lines create the progression of geometrical forms. This theory of proportion ultimately leads beyond measurement to the harmony of music (*agendo priùs de geometrica proportione, deinde de musica*).[226]

Tractatus XIV, *Pars Secunda*, pertains to the progression of the harmonic line (*De Linearum Progressionibus Harmonicis*). The center of harmonics is the point which meets in lines of musical proportion with other lines, creating an increasing division of lines.[227]

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[220] Johannes Kepler, *Harmonices Mundi* (Linz, Austria: Godofredi Tampachii, 1619).; Athanasius Kircher, *Musurgia Universalis Ars Magna Consoni et Dissoni* (Rome: Hæredam Francisci Corbelletti, 1650).; Jacques de Billy, *Tractatus Proportione Harmonica* (Paris: Michaelem Soly, 1658).
[221] Ibid., 248.
[222] Ibid.
[223] Ibid.
[224] Ibid., 249. Guarini references several ancient sources that pertain to this problem, including Christopher Clavius and Betinus Aerarij, whose theories both affirm earlier Platonic methods.
[225] Ibid.
[226] Ibid., 256.; Tricomi, *Matematico*, 554. "*Come ho già avuto occasione di accennare, il Guarini ha il merito non molto comune di indicare sempre le fonti di cui si avvale, sicché quando, all'inizio del Cap. XVI del suo* Euclides*, scrive: 'questo è tutto mio' gli si può credere. Il guaio però è che si tratta di contributi di modesta portata e non sempre ineccepibili. Per esempio, uno dei principali problemi risolti in questo Cap. XVI, è quello — facilissimo — di dividere un dato segmento in parti in progressione aritmetica; ciò che si ottiene con una semplicissima construzione di certi triangoli simili.*"
[227] Ibid., 263. "*Centrum harmonicum est punctum, in quo plurimæ lineæ conveniunt musicas in proportiones aliquam lineam; vel aliquas lines dividentes.*"

The relationship between the proportional division of geometry and harmonics in music creates an understanding of acoustics that is applied in architectural design (*omnes proportiones musicæ similes sunt in proportione geometrica alteri ab unitate denominatae, si tamen sint rationales*).[228]

Tractatus XVII pertains to rational proportion (*De Proportionalibus Rationum*) and the universal laws of every quantity, measurement, surface and application (*omni generi quantitatis applicandae*).[229] This system of proportion primarily pertains to similitude (*proportionibus similibus*), invention (*reperire*) and combination (*componere proportiones*).[230]

Tractatus XVIII pertains to the curvilinear line (*De Flexis*), which takes primacy over rectlinear lines and forms because the circle, which is constructed of a curvilinear line, existed first and inscribes all other forms (*ideo omnes etiam, ut earum latera considerentur; priùs de ipsis flexis agendum est, & in primis de circulo*).[231] Guarini begins with a description of the circle and its measurement (*De circuli descriptione, atque mensura*).[232] A curvilinear line is formed through the movement of a point by creating exterior angles according to the movement of that point (*quae corporum sectionibus exoriuntur, quae per motum puncti*) and extending a plane around those constructed angles.[233]

Several forms are generated from this curvilinear movement, including the hyperbola (*hiperbola, & aliqua talis quae per lineae motum*) as well as the helixical cylinder, cone and the rotating sphere (*helix cylindro, seu cono, seu sphere circumvoluta*), the spiral and the asymptote (*spiralis conchilis, asymptotos*), the circular plane and sphere, the ellipse and the conical cylinder (*ellipsis, & cylindro conoque*), which are created by the extension of planes from two points (*etiam plano duobus centris adhibitis*).[234] Guarini's generative description of these forms demonstrates the free extension of planes from the center, relating structure to movement, architecture to gnomonics, *macchinaria* and the motion of the universe (*licet facilis descriptio circuli sit cum planum liberum est*).[235]

Tractatus XIX pertains to the study of angles (*De Angulis*) and specifically to the less elementary relationship of triangles to other forms, which was not originally discussed by Euclid in the *Elements* (*quae elementaria non sunt tradenda, quae tamen necessaria ad multa in sequentibus percipienda*).[236] *De Angulis* involves the isoperimetric interaction between triangles with spheres and the measurement of solid bodies (*tractavi de sphericis, tum stereometriae, & multis alijs*).[237] The dual significance of stereotomy lies in the measurement of solids, as well to the science of precision stonecutting.

Adhering to Guarini's original proposition that all forms are inscribed by the circle, all other geometric structures generate from the point at the center of the circle. The universality of this proposition holds true according to the teleological design of nature and

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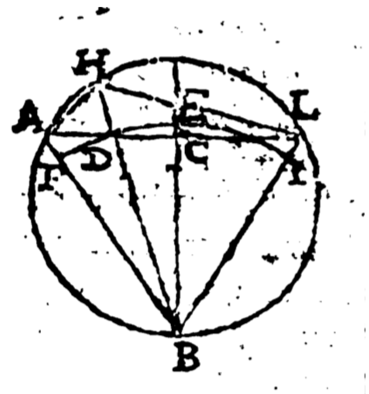
228 Ibid., 265.
229 Ibid., 271.
230 Ibid., 272, 274, 275.
231 Ibid., 286.
232 Ibid.
233 Ibid.
234 Ibid.
235 Ibid.
236 Ibid., 300.
237 Ibid.

the universe and to the three principles of Guarini's theory of architecture. Angles extending from the center or the edge of the circle form arcuate systems, much like the passage of light and shadow which extends from the gnomon upon the face of the sundial. Guarini describes this as a relationship between lines or chords that, like music, create major and minor lengths of proportion, creating harmony within the arcuate system that is brought about by their interaction (*maior arcus habet maiorem proportionem ad minorem; quam chordis maioris ad chordam minoris in semicirculo*).[238]



De Angulis, pg. 301

Tractatus XX pertains to lines which may be inscribed within the circle (*De Lineis circulo circumpositis*) as well as the properties of linearity and the surface planes that they create (*visis linearum proprietaribus secundum se, modo incipimus eas considerare, ut margines superficiei*). *De Lineis* is an analysis of the rectilinear figures that may be subsected within the figure of the circle, which are then analyzed using a table to delineate them by degree (*tabulum sinuum ordinare, & omnino complere*).[239]

Tractatus XXI pertains to logarithm (*De Logarithmis*), which Guarini applies to the understanding of geometrical proportion based on arithmetic. He rightfully accredits the invention of *Arithmeticae Logarithmorum* to Ioannes Neperus Schotus (John Napier, 1550–1617) and its further development to Henrico Briggio (Henry Briggs, 1561–1630).[240] The purpose of logarithmics is to bring about the proportional unity of geometric length with arithmetic (*annalogia verò, & similitudo, quam habent invicem proportionales arithmetici, & geometrici in causa fuit, cur simul unirentur, quàm hic diversis propositionibus explicabimus*).[241] The division and subduction of numbers creates logarithmic patterns that

[238] Ibid., 301.
[239] Ibid., 307.
[240] Ibid., 324.; R.P.Io Baptista Ricciolio, *Chronologiæ Reformatæ, Tomus Tertius* (Bologna: Hæredis Dominic Barberij, 1669), 249.; Ioanne Nepero, *Mirifici Logarithmorum Canonis Descripto* (Edinburgh, Scotland: Andreæ Hart, 1614), 1. The arithmetical nature of logarithmics relates to the geometry of trigonometric functions. Napier also included an extensive section on spherical trigonometry in his *Mirifici Logarithmorum*, which Guarini references more extensively in *Tractatus XXVII*.
[241] Guarini, *Euclides*, 324.; Ibid., 335. A similar explanation of arithmetical and geometrical unity is explained more elaborately by the following passage as well: "*Geometrica proportione semper eadem crescendo, vel decrescendo continuè se moveat singulæ eius partes assignabiles eadem proportione invicem correspondere debebunt cum sint omnes eiusdem rationis, & essentiæ. Ita si sit linea AB, quæ crescat continuè, & Geometricè, & augmentum mensuretur, à linea XV æqualiter crescente & Arithmetica, ita quod dum crescit Geometrica ab A in C illa Arithmetica crescat, ab V in T….*"

create geometric and sinuous (curvilinear) patterns and structural development (*sicut trium sinuum proportione geometrica continuatorum quadratum*).[242] These patterns can be multiplied into three-dimensional forms and supersolids by what Guarini calls"'tripling the cube' by five according to logarithmics" (*triplatus cubi quituplatus supersolidi*), a geometric operation that predates the quantum discovery of the supersolid, such as the Bose-Einstein Condensation in 1924–25.[243]

Tractatus XXII pertains to the intersection of planes (*De Intersectionibus Planorum*) which he bases on the *Sphaericis* of Theodosius of Bythinia (160–100 BC) and the *Conicis* of Apollonius of Perga (late 3rd to early 2nd C. BC). Guarini's analysis of the intersection of planes involves rectilinear angles produced by planar divisions, as if caused by the reflection of mirrors (*speculum*); one plane produces another according to its reflection upon the surface of the adjoining plane.

Tractatus XXIII, Pars Prima, pertains to the science of celestial bodies (*sphaericorum*) and the geometric forms with which they intersect and make contact (*De Sphaera contactibus, & sectionibus in genere*). The more specific purpose of *Pars Prima* pertains to solving a problem concerning spherics which may be solved by way of triangulation (*est necessarius ad triangula sphaerica sine errore solvenda*).[244] *Tractatus XXIII* also serves as a precursor to the research involving the triangulation of the celestial sphere presented in Part One of the *Caelestis*, which would be published in 1683.

Guarini describes that the sphere generates from the point by extending lines to their furthest point, forming equidistant points which connect everywhere, circumscribing the point and creating a surface (*sphaera est figurae solida una superficie comprehensa circulus aequalibus ubique circumscriptibilis, ad cuius extimam superficiem à puncto linea media terminates, aequales sunt*). The axis of the sphere is guided by the movement of the center and ends at the surface of the sphere (*axis sphaera est recta quaedam, qua per centrum transit, & in superficiem sphaera terminat*). The poles are the extreme points of its own axis (*poli sunt extrema puncta ipsius axis*).[245]

Triangular divisions occur when a pole spins on its axis (*terminantes axem*), generating lines upon its surface (*centrum spherae transfeuntum*). Because the pole is any point relative to the surface of the sphere (*quia omnes linee*), this triangulation can generate to any other two points on its surface.[246] The maximum inclination of an arc is brought about through the acute inclination of its own plane past the point of perpendicularity (*circulus maximus ad maximum inclinat cum arcus minor quadrante circuli utrique perpendicularis eorum inclinationem mensurat*).[247]

Since the sphere is a plane which emanates from a line which is undivided, those lines do not connect with a number of points but rather with one (*sphaera planum, vel lineam, in eo, à quâ non secatur, non tangit in pluribus punctis, quam uno*).[248] This is related to triangulation within the circle because Guarini states that a perpendicular shaft (*radius*) extended from the pole (*polo*) creating a circular periphery from the center due to

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[242] Ibid., 325.; Tricomi, *Matematico*, 553.
[243] Ibid.
[244] Ibid., 354.
[245] Ibid.
[246] Ibid.
[247] Ibid.
[248] Ibid., 356.

the interval (*intervallo*) of its rotation (*describator portio circuli*).[249] This theory functions as a form of triangulation and relates Guarini's theory of architecture to gnomonics. Triangulation also relates to polygonal geometry, which was used from the time of Archimedes until the advent of infinitesimal calculus in the seventeenth century to approximate π, the ratio of a circle's circumference to its diameter.

Tractatus XXIII, *Pars Secunda*, pertains to the greatest possible reciprocal intersection of planes within a circle (*De intersectionibus maximorum circulorum invicem*). The intention of this form of triangulation is to understand the various quadrants of space, both triangular and rectangular, which are produced when arcs are created through the interaction of two perpendicular lines, such as the *polo* and the radius (*duo perpendiculares arcus sint quadrante*).[250]

Guarini derives the knowledge of *Pars Secunda* from Euclid's *Elements* but also from Menelaus of Alexandria (70–140), Gebrus (Abu Musa Jabir al-Hayyan, 721–815), Johannes Maurolycus (1494–1575), Nicolas Copernicus (1473–1543), and Regiomontanus (Johannes Müller von Konigsburgh, 1436–1476); all of whom published treatises pertaining to spherical geometry, light, triangulation and its association to solar and celestial mechanics.[251]

Tractatus XIII, *Pars Tertia* involves the circularity of the sphere and the circular planes that may intersect it (*De maximorum circulorum in sphaera, minorumque intersectionibus, contactibusque mutuis*).[252] The geometries in *Pars Tertia* maintain the greatest significance when applied to the astronomy presented in the *Caelestis* and in their direct application to Guarini's architecture, most notably in the design of the central dome of San Lorenzo as well as the dome above the sanctuary and its peripheral geometries.

This geometric function lies in the interaction between concentric or parallel rings (*maximus circulis parallelis*), which make contact with the sphere and are inclined at varying degrees (*diversam continuè tangentium esse inclinationem*) according to their subtense (*portiones diametri subtensae arcubus aequalibus, quò propinquiores fiunt alteri diametro in quadrante, eò sunt maiores*).[253]

Tractatus XXIV pertains to the study of conics (*De Sectionibus Conicis*) and to their sections which create triangular, circular, hyperbolic and parabolic forms, the geometric principles of which he rightly accredits to Apollonius of Perga (*huius verò mirabilis cognitionis promotor, & ampliator fuit Appollonius Pergeus, qu ob id principis geometrae nomen consecutus est*).[254]

Guarini relates the nomenclature of conics to conifer trees and the shape of pinecones (*nux pinea*), which mathematically represent a kind of round pyramid (*pyramidem*

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[249] Ibid., 357.
[250] Ibid., 370.
[251] Menelai, *Sphaericorum*, *Libri III* (Oxford: Sumptibus Academicis, 1758); Gebri Arabis, *Philosophi ac Alchimistae Acutissimi* (Strasbourg, Germany: Lazari Zetzneri, 1598); Francisci Maurolyci, *Theoremata Lumine; Diaphanorum Partes, Seu.; Problemata ad Perspectivam* (Lyon: Apud Bartholomæum Vincentium, 1563), 60. "*Radij verô intra sphæram transperentem à centro àeqè remoti, qui paralleli non sunt, ad idem utrinque signum cum sphæræ diametro à fractionum terminis æquidistanti concurrent…*"; Nicolai Copernici, *Torinensis de Revolutionibus Orbium Cælestium, Libri VI* (Basel: Henric Petrina, 1543); Ioannes de Monteregio, *Tabulæ Directionum Profectionum* (Vvitenbergae: Matthæi Vellack, 1584).
[252] Ibid., 373.
[253] Ibid., 381, 382.
[254] Ibid., 390.

rotunda, cuius basis circulus). The periphery of the circle creates rectilinear vertices that meet at the vertex (*peripheria circuli ducuntur ad verticem*).[255]

The distinction is made between the geometry of the parabola, which ends at the point of its axis (*planum secant parallelum uni lateri sectionis per axem adigitur*), and a hyperbola, the planes of which continue through the axis point, creating vertices which face the opposite direction (*planum secet utrunque conum ad verticem erunt opposite figurae*).[256] Guarini demonstrates that an ellipsoidal section is created by drawing a chord across the base of the parabola (*quadrate segmentis chordae*) and extending rectilinear angles upward (*rectangulorum altitudines*) where they meet at a point upon the vertical surface of the cone.[257] The significance of the ellipse is evident in the design of San Lorenzo in the formation of catenary curves that constitute the central dome as well as the perimeter of the space above the sanctuary.

Guarini describes the position and function of the *umbelicus* in which the curved surfaces of a hyperbola are equal to one another (*umbelicus est quoddam punctum intra sectionem, quod insignes proprietates obtinet, maximè ad ipsarem sectionem*).[258] Guarini creates a parametric set of equations (*parametrum*) that describes the formation of ellipses caused by the binary movement of two points (*focos*). The interaction between hyperbola and ellipse provides a description of an intricate geometry of triangular vertices that are subsected at various tangents. It is this level of geometric intricacy that influences Guarini's architectural design—not only in terms of the solid structures that constitute the building itself but the way in which the light of the sun interacts within the space.

Guarini's analysis of conics is exquisite, providing a spatial understanding of the geometries connected to the parabola and hyperbola but also connecting them to the theory of gnomonics (*gnomonem*), represented by quadrangles (*quadratum*) that extend from the *umbelicus*. Guarini applies the term *permutando*, emphasizing the transformational nature of light in relation to movement in his system of geometry, which leads to a careful analysis of the asymptote (*de asymptoto hyperbolarum proprietate*).[259]

Guarini describes the asymptote as two tangential planes within the hyperbolic cone that move beyond its perimeters (*extra conum extenso efficiunt*) and the potential of mathematical comprehension (*inutilis contemplatio*).[260] The asymptote is important in relation to gnomonics and horology in Guarini's theory of architecture, which he applies to the design of San Lorenzo's dome.

While gnomonics and horology are related to the analysis of quadrangles and parametrics, Guarini states that the infinite nature of the asymptote is created by the expansion of the singular point (*datus eius asymptotis, & unico eius puncto*). Guarini describes the formation of an ellipse predicated upon the expansion of this unified point that is described by a diagram that also appears in the *Civile* as well as in Book Six of the *Elements*. The diagram applies to the structure of the sanctuary space of San Lorenzo and to the expansion of the center point to the sanctuary dome.

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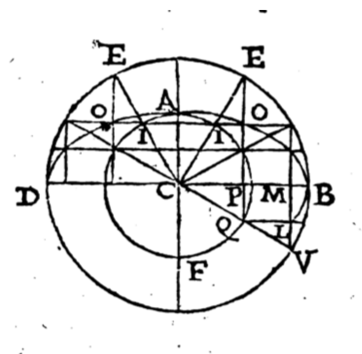
[255] Ibid.
[256] Ibid., 391.
[257] Ibid., 393.
[258] Ibid., 406.
[259] Ibid., 416.
[260] Ibid.



Guarini, *Euclides Adauctus*, 429

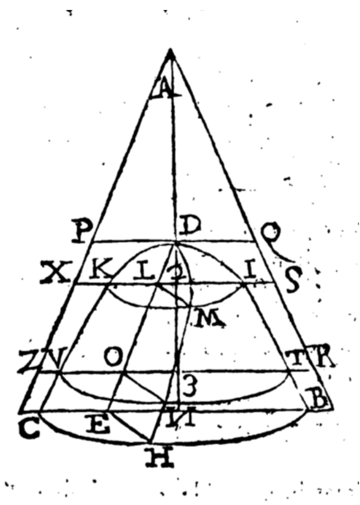
Tractatus XXV pertains to spherical sections created by the relation of surface planes and how they relate to orthographic and stereometric projection from the circle and the sphere (*proiectiones, tum sphaerae, tum circulorum, seu orthographicè, seu stereometricè mirabiliter deserviunt*).[261]

The relationship between the sphere and surface planes leads to the study of parabolic and hyperbolic conoids, in which the surface of the cone twists (*conoides parabolicum parabola circa suum axem volutata formatur, & axis eius est axis etiam parabolae genericus*).[262] The direct relationship that this geometry bears on San Lorenzo and Guarini's studies of gnomonics, quadrangles and parametrics, is the apparent spinning motion experienced by the viewer as one looks upward toward the dome.

This motion is expressed with elegant precision as a perimetric relationship of rotating planes within a parabola (*nam eius ambitus formabitur à puncto c per motum parabolae circa axem aq…cumque perimetrum parabolae maneat semper invariatrum punctum*).[263] The point, representing the *axis mundi*, is invariant; the perimetric movement, the spinning motion of the conoid is, in cosmographic terms, the movement of the celestial sphere around that point as it tends toward the infinity which surrounds it (*sit conoides hyperbolicum tdv, & figurae ex generatione eidem tdv asymptoti sint ba, & ac*).[264]

It is in the perfect equanimity of its movement that the asymptote approaches the infinite (*quibus perfectis erunt omnes aequales*), its planar divisions (*quadratum*) represented by the shadow cast by the gnomon (*gnomone ambiens quadratum*).[265] Guarini studies the effects of light and shadow within parabolic and hyperbolic structures in order to create domes which serve as sundials and spherical astrolabes, such as the dome of San Lorenzo.[266]

[261] Ibid., 436.
[262] Ibid., 440.
[263] Ibid.
[264] Ibid., 441.
[265] Ibid.
[266] Gibbs, *Sundials*, 11. The sundial may have led to the definition of conics by Menaechmus in the fourth century B.C. "Certainly a plane sundial with perpendicular gnomon always pointing to the culminating sun embodies the conditions which determine a hyperbola in Menaechmus's theory."



Guarino Guarini, *Euclides Adauctus*, 441

Tractatus XXVI pertains to projective geometry (*De Proiecturis*), *Pars Prima* to orthography (*De Orthographia*), and *Pars Secunda* to stereography (*De Stereographia*).[267] Projective geometry serves as an extension of the principles presented in *Tractatus XXIV* and *Tractatus XXV* in which the principles of gnomonics are connected to horology (*tum horologijs, tum instrumentis mathematicae*) the astrolabe, quadratics and cosmography (*astrolabio, & quadrantibus: tum cosmographiae*). Guarini directly applies these princples to architecture (*maximè architecturae ad proicienda corporum*) and to the planes of extension that are created through the oculus of the building, connecting it to the sun and to the stars (*ocularis prospectus representatur in planum extendere oporteat, & ipsa quoque corpora, superficiesque in planum proicere*).[268]

Expensio I pertains directly to architectural design and engineering. Guarini refers to Vitruvius' *De Architectura* stating that while the purpose of columns is structurally intended for the extension of walls, the purpose of the echinus of the Ionic Order (*cymacia coronides*) is to point in the direction of the projectional plane (*proiectionem dicimus figuram*), like the demarcations on the surface of a sundial. In the architectural grammar of the Ionic Order, these demarcations are represented by an egg and dart pattern or another kind of motif, which are often thought of as purely decorative, but in fact, serve a theoretical and mathematical purpose.

In Guarini's chapter on determining the proper site of a building (*Del Modo di Rilevare i Siti*) in the *Architettura Civile*, the demarcations are represented upon the surface of a magnetic compass (*bussola della calamità*), which is divided into three-hundred-and-sixty degrees.[269] The magnetic compass, differently than the sundial, allows the architect to determine the location of a building site and its proportions according to the geographical placement upon the earth (*della natura dei siti, e loro proporzione in quanto angoli del*

[267] Guarini, *Architettura Civile*, 73, 191. *Trattato III*, *Della Ortografia Elevata*, and *Trattato IV*, *Della Ortografia Gettata* of the *Architettura Civile* are mathematically connected to the orthographic principles presented in *Tractatus XXVI* of the *Euclides*.
[268] Guarini, *Euclides*, 444.
[269] Guarini, *Civile*, 45.

mondo).[270] Once this location is established, the building may be properly aligned with its solar and celestial coordinates.

It is the sun that defines projection (*solet definire proiecto*), but without the shadow cast by the gnomon, form and structure cannot exist. It is not possible for that which is impermeable to light to transcribe form; the sun itself is a single surface that is beyond transcription (*siquidem res solida nunquam potest in planum transcribi; sed solùm illius singulae superficies: quibus super planum descriptis; deinde res ipsa solida representatur*), thus allowing the intellect to perceive its dimension (*licet hoc sensu intellecta, vera evadat; aptiùs tamen videtur definienda*) as the form and structure of the building is reflected upon the surface of the projected light.[271]

Guarini defines orthography and stereography as two types of projective geometry; orthography being caused by light which is projected through a rectilinear form, such as a pyramid; stereography being that which is caused by light projected through a circular form, such as a cone.[272] Orthography is not based on the infinite perception of the eye (*orthographia non nascitur à distantia oculi infinita*), but rather upon the impression of visual lines which depart from their origin (*plani primigenij descedentes*).[273] Distance is based on the totality of its foundations (*distantia quoq totius subiecti*); the projection of orthogonals is unchanging and immutable (*licet in orthogra hia nihil immutet*) from the point which generates those foundations.[274]

The foundation of stereography is in the division of planes upon the surface of that which the eye perceives (*stereographiam oculum tribuentem*), a foundation which emanates from the center of the sphere from which it generates (*centrum stereographum admittitur ipsam super speram*) at a point within the pupil (*pro pupilla*).[275] Stereographic projection generates from the center of the sphere, rather than by way of the orthographic assemblage of surface planes and is, therefore, not a subject that is perceived before the eye as the instrument of vision (*ergo descriptio haec non pendet ab oculo*) but is instead perceived within it at its core.[276]

Guarini defines orthographic and stereographic projection as being transmutable according to the positioning of form, plane and distance (*tria proiectionem immutant, situs rei, situs plani, & eorum distantia*).[277] Distance, however, is orthographically immutable (*distantia quoq totius subiecti, licet orthogra hia nihil immutet*), while stereography greatly alters the magnitude of forms (*stereographia tamen valdè figuras alterat, & in diversam magnitudinem diducit*).

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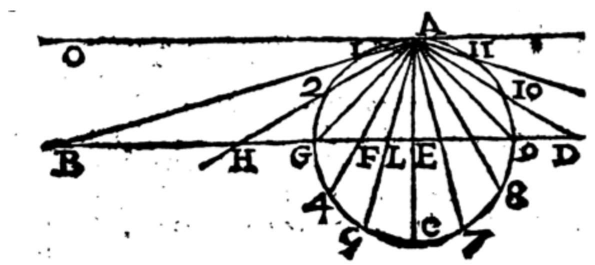
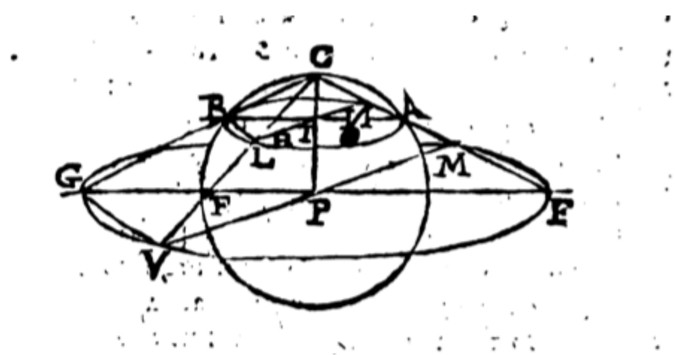
[270] Ibid., 48.
[271] Ibid.
[272] Ibid., 445. "*Probat. auctoritate Mathematicorum, qui ita sufficienter divisisse proiectionem arbitrari sunt, tum quia superficies, que aliam ambit duplex solùm esse potest, nempe sibi, fuisque partibus parallela, ut prisma, & Cylindrus. Aut non parallela, sed in unum punctum contendens ad instar coni, aut Pyramidis; si superficies illa sit parallela sibi, fuisque partibus, dicitur eius impressio facta in plano orthographia: si verò sit ad modum pyramidis, vel coni in punctuque conveniat, dicitur Stereographia, et hinc utraque definietur.*"
[273] Erwin Panofsky, *Perspective as Symbolic Form*, trans. Christopher S. Wood (New York: Zone Books, 1991), 35. Panofsky refers to the difference between orthography and stereography by comparing the linear perpective of the Renaissance, to 'antique' optics, such as that of the Middle Ages, and of Euclid, which "conceived of the field of vision as a sphere."; Ibid., 444.
[274] Ibid., 445.
[275] Ibid., 445.
[276] Ibid.
[277] Ibid.

The relationship of Guarini's theory of projective geometry to gnomonics becomes evident in a closer examination of his Latin in which "*distantia quoq totius subiecti*" pertains to the totality of distance that is subjected to the immutable nature of rectlinear, orthographic lines and planes. However, *subiecti* is also defined as the base-plate of the sundial, a definition applied by Vitruvius in the *Ten Books*, in which he states in Book Ten that the foundation (*subiecto*) of the aperture of a building is of a greater length and width than a column or shaft upon the surface of the floor (*subiecto foraminum* [*sic*], *latitudinis et crassitudines eiusdem, cuius minor columna illa*); the floor acting as the plate of the sundial, as in the example of the disc of light which enters through the oculus, circumnavigating the floor of the Pantheon. In Book Nine, Vitruvius also states that the entire measurement of time is described upon the sundial's plate according to the analemma, the latitudinal diagram which shows how the length of the shadow changes with the time of year (*subiecti onibus rationes horarum erunt ex analemmatos describendae*).[278]



Guarini, *Euclides Adauctus*, 454

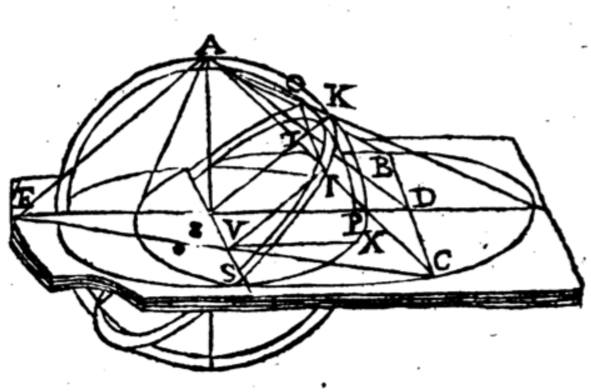
The circle is the sphere; the orthographic lines, which are extremities of Point A (the gnomon point of the sundial), dimensionally extend into the form of the conic section. The base of the cone is the base of the circle (*coni enim, cuius basis circulus*), the circumference of which is the rotational course of the celestial sphere around the luminous center of the sun.[279] As the angle of this base shifts into obliquity (*circumferentiam obliqui circuli*), the



Guarini, *Euclides Adauctus*, 455

[278] Glare ed., *Oxford Latin Dictionary*, 1840.
[279] Ibid., 455.

poles coincide with the shifting planes (*polos in plano proiectos*) to create the form of the sphere itself (*ipsius spherae describatur*), creating sections and bifurcations within it (*stereographum ex definitione secet spheram bifariam*).[280]



Guarino Guarini, *Euclides Adauctus*, 457

The resulting geometry is striking in its similarity to that of the dome of San Lorenzo, with its interlocked catenaries that enclose the arc of the circle with projective angles (*subtendens arcum*).[281] The construction of San Lorenzo was from the date of commission in 1668 to its consecration in 1683. As the *Euclides* was published in 1671, diagrams such as these, which describe the arcuate division of a spherical surface, ostensibly pertain to the designing of San Lorenzo. The divisions of the sphere are clear inspiration for the dome, and the projection of circular forms upon the plane created by the base of the conic section may have also served as the theoretical basis for the interlocked circular geometry of the sanctuary space of the church.

Tractatus XXVII, *Pars Prima* pertains to triangular planes which support the diameter of a sphere (*De Trianguli plani cruribus dimetiendis*); *Pars Secunda* pertains to the solution of spherical problems of trignometry (*De Triangulis sphaericis solvendis*), which also demostrate the connection of spherical geometry to astronomy and the celestial sphere.[282] Spherical trignometry supports the radius, thereby structrually reinforcing the curvature of the sphere.[283] Trigonometry is theoretically important to Guarini's cosmology of architecture (*gnomonica*, *orologia*), but it is also structurally important to the art of building (*edificare*), engineering and construction (*macchinaria*).[284]

The basis of measurement in astronomy is spherical triangulation (*triangulorum sphaericorum doctrina astronomiae & astrologiae basis est*), as it is relied upon as the

[280] Ibid., 456.
[281] Ibid., 457.
[282] Guarini, *Euclides*, 463, 471.
[283] Ibid. "*In omni triangulo rectangulo, si basis est radius; etiam duo crura sunt sinus arcus, & sinus complementi illius arcus.*"
[284] The practical use of trigonometry can be seen in the *Chiave della cupola* of San Lorenzo.

foundational practice of spatial division (*diffissi solis praxibus potius incubuere*).[285] Multiple solutions are formed by placing the sphere within the triangle (*triangula sphaerica*) and the rectangle (*de rectangulis sphaericis*). The proportions of curvilinear angles (*proportio sinus anguli*) may be determined by measuring their subtended angles against rectlinear angles (*sinus complementi cruris reliquum angulum subtendentis ad sinum complementi ipsis anguli*).[286]

Tractatus XXVIII pertains to the advanced knowledge of surface structures (*de progressionibus superficierum*). The application of arithmetical calculation is discussed in detail, which provides the possibility of cubing the sphere (*arithmetica superficierum attingamus quae cubandis sphaeroidibus necessaria sunt*); a calculation which can only be approximated.[287]

Tractatus XXIX pertains to geodesy (*De Geodaesia Rectilineorum Planorum*) and the rectlinear planes which allow for dimensional measurement (*dimensionem per sensibiles mensuras*).[288] *Trattato V* of the *Architettura Civile*, *Della Geodesia*, applies the science of geodesics to architecture. Both treatises base the practical mathematics of geodesy on the initial work of Christopher Clavius and Ioannes Pediasimus (1282–1326); however, *Tractatus XXIX* incorporates the *Mathematical Lexicon* of Hyeronimus Vitalis as well.[289]

The *Euclides* establishes the science of geodesy as a continuum of transformational geometries (*de figurarum planarum rectlinearum transformatione in aequales superficies*), applying them to geospatial surfaces such as latitudes, longitudes, and the geometric interception of various planes (*interceptam distantiam*).[290] The intersection of these geometries, like the plucking of stringed instruments, are applied to the harmony (*harmonicè*), which radiates from the center of the sphere (*centri radiosi*).[291]

Tractatus XXX pertains to curvilinear transformations within the science of geodesics (*De Transformatione Curvilineorum*) which are based on the rectlinear transformation of the hyperbola (*hyperbola trasformari in rectilineas*). Guarini accomplishes this through the squaring of the circle (*de quadratione circuli arithmetica*) which, he admits, by way of a brief exposition on the history of the problem in mathematics, that only an approximation may be reached (*approximantem veritati proponere*).[292]

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[285] Ibid., 471. Jean Baptiste Joseph Delambre, *Histoire l'Astronomie Ancienne, in Two Volumes* (New York and London: Johnson Reprint Corporation, 1965), 49. "*Nous n'aons recontré dans Autolycus aucum vestige de la Trigonométrie qui seule aurait pu lui donner la théorie complète et la solution précise des diverses questions qu'il a mises en théorèms complète et la solution précise des diverses questions qu'il a mises en théorèmes vagues et souvent obscurs. Nous trouverons dans Euclide des propositions d'un usage indispensable en Astronomie, mais aucune règle positive et usuelle pour la solution des triangles.*"
[286] Ibid., 472.
[287] Ibid., 495.
[288] Ibid., 503.
[289] Hieronymo Vitali, *Lexicon Mathematicum Astronomicum Geometricum* (Paris: Ex Officina Ludovic Billaine, in Palatio Regio, 1668), 457, 657.
[290] Guarini, *Euclides*, 520.
[291] Ibid.
[292] Ibid., 457. "*Multi ne dum apud veteres; sed recentiores etiam, ut testatur Hyeronimus Vitalis ex nostris in suo Lexico mathematico in circulo Tetragonismum sc. quadrationem totius viribus incubuere, & quidem apud antiquos Antiphon, Bryso, Hyppocrates Chius. Inter Neoteoricos auté Orontius Finaeus, Campanus, Nicolaus Cardinalis Cusanus, desudarút, Sed ceteris sublimus Ambrosius à San Vincentio in insigni opere, quod de Quadratura circuli inscripsit totam ponè etatem consumpsit. Sed licet multa consequuteus fuerit omnino admiratione digna; tamen scopum assequutus no est. Nam eius quadraturas (quatuor enim protulit*

Curvilinear transformation is based on the movement of any circular form which causes the subduction and division (*ducto radio*) of any minor form within it (*figura qualibet circulo circumscripta maiorem obtinet ambitum, quàm circulus, sicut & figura inscripta maiorem*).[293] The triangle is subducted within the circle, creating a series of divisions, isoperimetric transformations, projected planes and curvilinear projections through the multiplication of spherical, elliptical, parabolic and hyperbolic forms.[294]

The movement of the circle into a spiral causes the subduction of all divided forms into any virtual quantity (*spirae inscribere, vel circumscrebere sestores tot, ut sint simul posita omnia spatia inter spiram, sectoremque conclusa minora qualibet data quantitate*).[295] Guarini concludes that division into thirds (*triens*), and division into forths (*rectangulum*) is equivalent to the greatest possible number; a number which can be multiplied *ad infinitum*.[296]

Tractatus XXXI pertains to the transformation of surfaces which cover corporeal bodies (*De Transformatione superficierum corporal circumvestientium*) in order to create an understanding of the surface planes which are created by various geometric forms.[297] Guarini theorizes that through the equal projection of surface area from the base of a cylinder cut at an oblique angle (*ungulus*), one may arrive at other forms with the same surface area, including the triangle and the cone.

From this transformation, yet another understanding of gnomonic projection is brought about through the multiplication of equivalent rectangles (*gnomonen illi rectangulo aequalem*) in which the elliptical bodies extend from the *ungulus* to form a diametrical point, creating a cone with a major and minor axis (*superficies sphaeroides elliptici est aequalis superficiei sphaerae, cuius radius media proportionalis sit inter axis maiorem, & minorem*).[298]

1.10 de quadratura circuli inscripto) *impugnant Vincentius Leutaudus proter multos alios, & evidentiùs deijcit, & licet Franciscus Xavierus Ayscon auborem propugnet. Id tamé libro Lugduni impresso anno 1663 nove impugnatone eidem Leutando locum dedit. Unde fatiùs iudicavi antiquam quadratum Archimedeam approximantem veritati proponere, quàm novum tetragonismum, & laboriorsissimum, & adhuc sub lite versantem producere.*"

293 Ibid., 528.

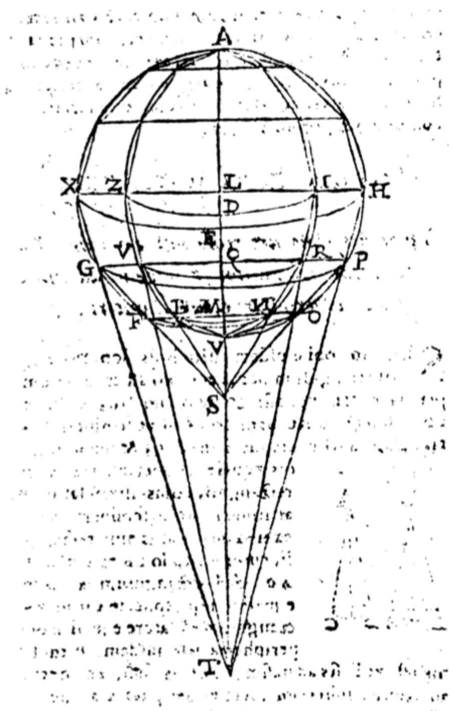
294 Ibid., 528–544.

295 Ibid., 545.

296 Ibid., 549. "*Spiralis spatij sectio est ad suum sectorum maximum circuli maximi comprehendtem eam sectionem, ut rectangulum ex lineis eam terminantibus simul, & triens quadrati ex eorundem differentia ad quadratum diametri circuli prædicti maximi comprehendentis.*"

297 Ibid., 550.

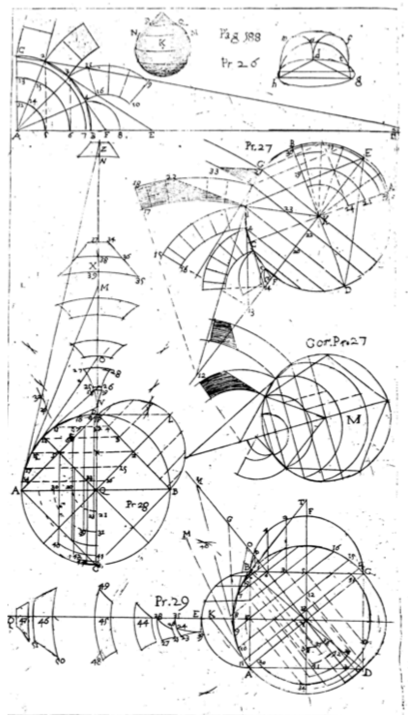
298 Ibid., 563–64.


Guarini, *Euclides Adauctus*, 564

Guarini's schematic of a sphere created by an *ungulus* projecting a cone (*cum ergo singulae segmentorum conicorum superficies spheroide inscriptorum*) coincides with the structure of ancient Greek and Roman sundials: "By levelling the surface AB and hanging a plumb line which will intersect the oblique front plane, it is possible to form the angle Φ."[299]

Tractatus XXXII pertains to the conversion of planes and surfaces (*De superficiebus corporum in planum redigentis*) so that the circumvolution of elliptical, parabolic, hyperbolic, quadratic and asymptotic lines becomes an extension beyond the boundary of the sphere. *Tractatus XXXII* brings forth extensions of the spherical sections created by the relation of surface planes described in *Tractatus XXV*.[300] Guarini accomplishes this through the isoperimetric projection of the curvilinear surfaces of geometric forms into planes (*partesque eius proijcere, & deinde illam in planam extendere*).[301]

[299] Ibid., 564.; Gibbs, *Sundials*, 15, 97.
[300] Guarini, *Euclides*, 572. "*Proiecto superficierum corporearum, que in planum extenduntur, aliquibus videbitur forte non omninò Mathematica, cùm per puncta, per quæ habili mani lineæ flexæ ducuntur superficies eiusdem rationis, & quantitatis, ac illæ, quæ circumambiunt corpora describantur: Verùm si istæ consideret, quod & Ellipticæ, Parabolicæ, Hyperbolicæque superficies, ita delineatur, sicut, & Quadratices, & Asymptoticæ lineæ sic descriptæ in præcedentibus furere: non insitiabitur rigorosam esse hanc superficierum corporearum in planum extensionem, maximè, quia fundatur omnino in Orthographia, quæ certè Mathematica descriptio est. Verum tamen est, quod singulis proiectionibus ostensiones non adferemus cùm eas supra tract. 25. fatis produxerimus.*"
[301] Ibid., 573.



Guarini, *Euclides*, 588

This projection of planes is the transfer of the physical torque created by the spinning sphere, like a Ciceronian transfer of power (*redigens*) posited in geometric terms (*quin redigeret omnis fere in quadrum numerumque sententias*).[302] The connection between the celestial sphere and state power expressed in the *Oratore* is also established through Guarini's relationship to his patrons in the foreword of several of his treatises, including the *Placita Philosophica*, the *Modo di Misurare le Fabbriche*, the *Compendio della Sfera Celeste* and the *Caelestis Mathematicae*.

Tractatus XXXIII pertains to the inscription and circumscription of solids (*De inscriptione, & circumscriptione Solidorum*). The sphere is applied in the circumscription of

[302] M.T. Ciceronis, *De Oratore ad Quintum Fratrem Dialogi Tres* (Paris: Ex Typographia Thomæ Richardi, sub Bibliis aureis, è regione collegij Remensis, 1561), 268. This passage from the *Oratore* describes this transferable relationship between political rhetoric, science and physics, which according to the Platonic foundation of Cicero's political philosophy, was intended to be seen as an integral system: "*De iustitia publica præcipit Plato in libris de Rep. de officio Panetius, de civitatibus instituendis & regendis Plato de legibus & de Rep. & Aristoteles in Politicis. De omni ratione vivédi, idem Aristoteles in Ethicis. De ratione nature, idem in Physicis. Hœc quoniam iam aliunde accipi non possunt, sumenda sunt oratoribus à philosophis: à quibus expilati, direpti, spoliatíque sunt: nec discenda tractadá ve eo modo quo solet illi, sed ad civilem scientiam, euius pars est rhetorice, transferenda: & eorum fontes videndi potius, quàm omnes omni ætate rivuli consectandi.*"; 213. Martullii Ciceronis, *De Oratore, Libri III* (Venice: Apud Cominum de Tridino Montisferrati, 1544), 213. Another example from *De Oratore* is given here, in which Cicero states that the embellishment of language with the knowledge of art and science enriches the readings of orators and poets. "*...Sed omnis loquendi elegantia, quanquã expolitur scientia literaru, tamen augetur legedis oratoribis & poëtis...*" Glare ed., *Oxford Latin Dictionary*, 1590.; Gustavus Fischer, *Latin Grammar, Together with a Systematic Treatment of Latin Composition, Part Second, Containing the Details of Syntax* (New York: J.W. Schermerhorn & Co. Publishers, 1876), 547.

geometric solids (*globosis descriptionem*), advancing the comprehension of the sides of the figure (*corporum inscriptorum benè precedit soliditatis cognitionem ipsa laterum doctrina*).[303]

This comprehension is achieved by measuring the diameter of the sphere against the sides of geometric figures, such as the tetrahedron, pyramid or octahedron, creating a quadrature in three dimensions (*sphere posse efficere quadratum*).[304] Guarini states that an apotome (two quantities commensurable only in power) is created through the relationship between the sphere and the sides of the dodecahedron, which become irrational (*quòd dodecaedri latus irrationalis est linea, quae vocatur apotome*). Because the apotome creates a relationship between different quantities with equivalent powers, Guarini uses this as a way of creating a gnomonic system within the dodecahedron circumscribed by the sphere (*quae sunt equali gnomoni…siquidem ex hypothesi quadrata*).[305]

The gnomonics of the sphere are expressed by the turning of the radius of the sphere through the pole that intersects a cone (*segmenta tangentia intima spheram conoru describantur*) around the pole (*per centrum spherae, eorumque polos*).[306] *Tractatus XXXIII* allows for further advancement of the knowledge of geometric structures around the *polo*, or *axis mundi*, which may be applied in multitudinous ways to architectural design, and cosmology.

Tractatus XXXIV, Pars Prima et Secunda pertain to solid surface planes (*de solidis planis superficiebus contentis*) and to solid curvilinear forms (*de soliditate corporum curvorum*).[307] The first inter-figural solid (*prima inter figuras solidas*) is the parallelepipedis because each surface area of the solid is a parallelogram (*sint solidum parallelis planis contineatur adversa illius plana parallelogramma sunt aequalia, & similia*).[308] The surface area of each solid becomes its own solid, leading Guarini to a theory of various types of prisms (*prismata triangularis*).[309]

Tractatus XXXIV, *Pars Secunda* expands into an exploration of curvilinear solids such as the cone and cylinder, which creates the sphere and spheroidal forms when combined (*ut coni, & cylindri, alia sunt, quae superficie omnino curva absque ulla admixtione planitiei consequuntur, ut sphaerae, & sphaeroides*).[310] This leads to an exploration of gnomonic intervals as well as the formation of spiral within the cylinder.

Tractatus XXXV pertains to the relationship between corporeal bodies (*De Corporum comparatione*), creating a final corollary between several of the geometric forms found in the prior treatises (*quasi fructus antecendentium tractuum*) in order to explore what other forms they may be generated (*generis*) and transformed (*transformatione corporum*) through such comparison. In conclusion, Guarini explores tranformational geometries that move beyond quadriforms (*meta quadriformi*).[311]

The *Euclides* concludes with an extensive series of trigonometric sine tables, based on the theory of John Napier, followed by a detailed appendix. Guarini's mathematical

303 Guarini, *Euclides*, 597.
304 Ibid., 602.
305 Ibid., 602.
306 Ibid., 607.
307 Ibid., 609, 620.
308 Ibid., 609.; Euclid, *Elements, vol. 1*, 322–26.
309 Guarini, *Euclides*, 615.
310 Ibid., 620.
311 Ibid., 673.

accomplishments in the *Euclides* are rich and extensive. The architectural application of this complex description of geometric forms was presented in Part II, “The Church of San Lorenzo.”

APPENDIX V

MODO DI MISURARE LE FABBRICHE

The *Modo di Misurare* was published in Turin in 1674 by Heredi Gianelli. The treatise is dedicated to the painter Giovanni Andrea Ferrari, who was Count of Bagnolo and the minister of finance for the engineer, military architect and Duke of Savoy, Amedeo di Castellamonte. Ferrari was a prolific painter and draftsman, largely active in the region of Genoa.[312] Guarini states that the purpose of the treatise is to allow Ferrari to more aptly serve as finance minister for the House of Savoy.

As in the *Civile*, the *Placita* and the *Compendio*, the *Modo di Misurare* connects the measurement of buildings to the movement of the celestial sphere. Addressing Ferrari, Guarini states that the royal house is to be constructed as a machine that is meant to be perfectly aligned to the movement of the celestial sphere (*tanto bene moderna questa machina, che non vi e movimento di sfera sì perfettamente agguistato*).[313]

The architectural geometries of squares (*quadrate*), cubes (*cubati*) and the multiplication of surfaces and volumetric bodies (*superficij*, *corpi*) in the *Modo di Misurare* are based on Euclidean geometry, following a logical progression from the *Euclides Adauctus*, published three years prior.[314] Guarini's emphasis in the introduction is that the treatise is not intended for pure mathematics but for utility and practical application in the service of others, and for measurement in building.[315]

The treatise is intended to be a practical manual for measurement directly applied to building. Many of the formulas laid out in the *Misurare* are repeated later in the *Civile*, but according to much clarification and brevity. The other aspect of the *Misurare* which differs from the *Civile* is that there is no connection made between Euclidean demonstration and cosmology, only between geometry with a sole application to building.

[312] Mary Newcome, "Ludovico Caracci, Jacopo da Empoli, Giovanni Andrea de Ferrari: Notes on Three Drawings in the Palazzo Rosso in Genoa" in *Master Drawings* 23/24, 2 (1985/1986): 205.
[313] Guarino Guarini, *Modo di Misurare le Fabbriche* (Turin: Per gl'Heredi Gianelli, 1674), 3–4.
[314] Ibid., 7.
[315] Ibid., 7–8. "*Perche se bene il nostro Euclide tratto anche di trasformare, e partir le superficij, e i corpi; pure non hò voluto augumentare questi fogli con quelle prattiche…non hò mancato nel fine de aiutare l'intendimento di qualunque non essercitato ne termini Matematici, con spiegarne il significato, & in tal modo renderlo obediente, e facile ali' uso d' ogni studioso di quest' arte che se ne voligj servire.*"

APPENDIX VI

TRATTATO DI FORTIFICATIONE

The *Trattato di Fortificatione* is dedicated to Ludovico Giulio, Prince of Savoy, and is written with the intention of serving the Prince as a military architect.[316] The Savoy's military front was expanding and they were at war in Flanders, Douai in the north of France, at Oder Narden in Germany, and in Italy at Borgagna, Greci and against the Dola Family in Messina, Sicily.[317] Guarini expresses the need for Ludovico to support his father, Prince Louis Thomas, Count of Soissons.

Guarini was commissioned to write the Treatise on Foritification in 1666 while working as ducal engineer on the dome of the Chapel of the Holy Shroud. The treatise was published a year later. During this time, Guarini was also employed by the Duke's sister and by the Duke's first cousin Emanuele Filiberto, the Prince of Carignano (1628–1709). He later built the Palazzo Carignano for the Prince in Turin from 1679 to 1685 and renovated the feudal castle of Raconiggi, outside Turin. The Prince was a strong military leader, and Guarini was asked to instruct his nephew, Ludovico Giulio, in religion and mathematics. The treatise is dedicated to Ludovico, "most serene prince and knight of Savoy."[318]

Once again, Guarini emphasizes the importance of light in the first sentence: "This small work is my poor and humble treatise on fortification, brought forth from light." (*Quest'Operetta mia di Fortificatione povera, e dimessa, esce alla luce.*) In the *Euclides*, Guarini also states that "mathematics is brought forth from a single font of light" (*Mathematicas luces, & euidentias in unicum lucis fontem*).[319] Mathematics from light, geometry from mathematics, geometry to architectural form. At the core of this progression is the idea that light is synonymous with architectural itself.

The treatise begins by stating the importance of Euclidean mathematics for the military arts:

[316] Guarino Guarini, *Trattato di Fortificatione* (Turin: Appresso gl' Heredi di Carlo Gianelli, 1674), (unpaginated). "*Questo breve Trattato di Fortificatione ardisce di consecrarsi Ossequioso al suo Sereniss. Nome, con sicura speranze di dovere, sopra ogni dono, trovar gratioso aggradimento dell'animo suo generoso. L'armi, sopra ogn' altro arredo del finto Mercate Ulisse piacquero al feroce Achille, benche frate Donzelle in feminea veste molemente nutrito; portandalo l' indole sua bellicosa à quegli arnesi, che secondavono, non il vestito, ma il vivace suo brio.*"

[317] Ibid., "*Che saggio di virtù militare non pompeggio nel Conte de Soisons*."

[318] James McQuillan, "The Treatise on Fortification by Guarino Guarini" in *The Nexus Network Journal* 16 (2014): 619.

[319] Guarini. *Euclides* ("Benevolo Lectori"), unpaginated. "*Cum inter illos, qui in elementa Euclidis desudarunt, nullum intuear, unico concarcinare volumine, quæ ad quantitem sub genere investigandam faciunt, secutus seculi genium, quod centiuriat, ut plurimùm, & florilegia condit, putavi nequaquam me frugem perdere ; si huic muneri universaliùs inservirem, & Mathematica rerum exordia ex omni parte rotunda, & contornata exiberem. Siquidem ex meo labore didici, euius pretij, cuius utilitatis id operis emergat ; quod ea omnia, quæ Mathematicas luces, & euidentias in unicum lucis fontem, adeoq, solem ne dum tumultuaria collectione aglomeret ; sed etiam ordinato agmine disponat, in seriesq ; suas naturali consecutione distinguat præcipué illis, qui nullo Mercurio tramitis indice, aut duce audent se huic studio consignare, & admodùm dificilem provinciam in suam sarcinam traducere.*" It is interesting that the mention of Mercury's transmission referenced here within the untranslated part of this quote might in fact pertain to the planet's transit over the sun in 1661. This celestial phenomenon was also observed by the astronomer and contemporary of Guarini, Christiaan Huygens. This celestial phenomenon would have also allowed for certain astronomical observations exemplified in Guarini's *Cælestis*. This reference may also be observed in note 77: Ibid., ("Benevolo Lectori"), in which "Mercury transmits no indexical path…"

> Euclid's elements are necessary for each mathematical science, but you will not be able to gain something from this, if this first elementary understanding is not diligently worked into your mind; and for the most desired advances in the military arts, we understand, that this will be the base, the principle and the prime element, of which it is composed, and above which is proposed and originates each of your speculations.[320]

Preface One puts forth a series of definitions and axioms which are meant to offer the reader a brief, philosophical idea of the concepts within Euclidean geometry and their application to fortification systems. The importance of extending forms from a triangular base is emphasized for strength and stability. Preface Two of the treatise is instruction in elementary mathematics, from geometry, to arithmetic. The propositions become increasingly complex as the reader progresses.

The main body of the treatise is on military architecture (*Architettura Militare*) and is intended for being instructional for times prior to or during war in order to construct fortifications. There he gives specific instructions on how to build defensive fortifications for specific places in Piedmont. He presents the first principle of constructing fortifications: "Each part of the fortress has the ability to defend the city not only by direct offense from the front, but also by parallel and oblique defense."[321] This, in light of the first section on Euclidean geometry, demonstrates the universal relationship between surface and angle of incidence, translated into military stratagem.

[320] Guarino Guarini, *Fortificatione*, 5. "*Gl'Elementi di Euclide sono so necessarij ad ogni scienza matematica, che nó può profitare alcuno in esse, se in questa prima cognition elementare non è diligentemente versato; e per tanto qualonque vuole avanzarli nell'arte militare, deve credere, che questa sia la base, il principio, & il primo element, di cui si compone, e sopora a cui s'avanza, e cresce ogni sue speculatione*."
[321] Ibid., 37. "*Principio I: Ogni parte della fortezza dove potersi diffendere da cittadini non solo con offesa diretta, e per fronte, ma anche con difessa paraella, & obliqua.*"

APPENDIX VII

COMPENDIO DELLA SFERA CELESTE

The *Compendio della Sfera Celeste*, published in Turin by Giorgio Colonna in 1675, is dedicated to Giovanni Battista Truchi, advisor of the state, first president and head of the council of finance of the Duke of Savoy.

Another treatise concerning the celestial sphere, entitled *La Sfera Artificiale, e Naturale*, written by Ludovico Passerone, was published in Turin shortly after Guarini's *Compendio* by Bartolomeo Zapatta. Passerone's dedication is addressed to the Prince of Piedmont, Vittorio Amedeo di Savoia, dated March of 1675.

The *Imprimatur* of Passerone's treatise is written by Bartolomeo Torrini and is followed by a *Nihil Obstat* written by Guarini, under the order of Michele Ludovico Theunardi, Inquisitor General of Turin. Theunardi was also commissioned by Lorenzo Maccialdi to write the *Imprimatur* for Guarini's *Compendio* as well, which appears at the end of the document. Guarini states that everything in Passerone's treatise is free of any repugnance to the faith (theological error), that it is written clearly and that the power of its knowledge places it in the light of God.[322]

Much like Guarini's dedication to Torres in the *Placita Philosophica* and Ferrari in the *Modo di Misurare*, the commemoration of the *Compendio* to Truchi discusses the celestial sphere, not only in light of astronomy, but in terms of politics and power. Guarini expresses that while the effect of his book may be small, its subject matter is of vast proportion and may serve to amplify the power of the duke (*Effeto è il libro delle mie deboli forze, la materia di lui è una vastità proportionata all' ampie sue prerogative*).[323] Guarini states that the sphere (*così questa mia sfera*) will be like nothing else that has ever affected the greatness of his intellect (*sarà come niente capita dal suo gran intelleto*), effectively putting the duke at the center of command (*al centro di suoi ambiti commandi*).[324] Guarini also emphasizes that the heavens are at the duke's disposal; that they have no other locus than him at the center (*questo nostro cielo non hà altro loco*), appealing not merely to the fervent desire to rule, but also alluding to the egocentric adherence to geocentric theory that came along with it in the seventeenth century.[325]

Passerone's dedication to Vittorio Amedeo in his treatise on *La Sfera* is similar in nature to Guarini's, expressing that this "material sphere" will bestow the prince and his line of royalty a universal power (*che doveva haver dell' Universo*) as a tool for rulership, power and conquest (*possesso del suoi vastissimi Regni animarlo à maggiori conquiste*).[326]

It is perhaps an oversimplification, however, to only think of these royal introductions as an appeal to power. Guarini's *Compendio*, as well as Passerone's *La Sfera*, would have been seen as theoretical but also practical, didactic and pragmatic to a ruling class during the seventeenth century in the broadly expanding Age of Exploration. Expanding on many of Guarini's ideas, Passerone connects the horology of the sun to mechanics,

[322] Ludovico Passerone, *La Sfera Artificiale, e Naturale* (Turin: Bartolomeo Zapatta, 1675), (unpaginated). "*D' Ordini del Reverendiss. Padre Michele Ludovico Theunardi di Inquisitor Generale di Torino; Io D. Guarino Guarini di Chierici Regolari Thelogo, e Matematico hò revista* La Sfera Artificiale, e Naturale *del Sig. Ludovico Passerone di Lantosca Dottore d'ambe le Leggi, e non havendo in essa conosciuta cosa, che repugni alla Fede, buoni costumi; anzi per ogni parte molto chiara, e facile, stimo si possa porre alla luce.* D. Guarino Guarini C.R."

[323] Guarino Guarini, *Compendio della Sfera Celeste* (Turin: Giorgio Colonna, 1675), (unpaginated).

[324] Ibid., (unpaginated).

[325] Ibid., (unpaginated).

[326] Passerone, *La Sfera*, (unpaginated).

which can be used for civil, nautical, or military engineering.[327] The facility of power is that of navigation, which is made possible by determining terrestrial coordinates according to the movement of the sun and the stars and one's relative position upon the surface of the earth.

Guarini presents his hypothesis in the *Preludio*, which is to explain the movement of the heavens and to predict eclipses by way of the *primum mobile* and the horology of the sun, according to astronomical tables (*hipotesi spiego i movimenti celesti e già composte le tavole di secondi mobili* [*sic*] *à predir l'eclisse, parte a primi mobili, & alli horologgi da sole*).[328] Guarini states that the *Compendio* is a brief preamble to what follows, alluding to the *Caelestis Mathematicae* which would be published twelve years later.[329] He states that his intention with the *Compendio* is to present the reader with a clear, fundamental knowledge of the science of the celestial sphere, for those who cannot be afforded the time to read such a large volume or to indulge their thoughts in greater speculation (*non havendo tempo di leggere un gran volume, ò non si dilettando di profonde speculatione*).[330]

Guarini's hypothesis in the *Compendio* is connected to his architecture theory. The understanding of the movement of heavenly bodies around the celestial sphere relates to the knowledge of gnomonics, the connection of architecture to the movement of the passing sun. If the shadow cast by the gnomon of the sundial is instead a fenestration within the dome of a church such as San Lorenzo, then the shadow is instead a shaft of light—a corpuscular beam moving around the interior of the dome, demarcating time and the seasons within the movement of the sun in the heavens.

In Chapter One of the *Compendio*, Guarini describes the sphericity of the heavens (*Della rotondità del Cielo*), fortifying his claim by referencing a number of ancient and early modern astronomers, including Geminus of Rhodes (fl. 1 c. BC), Cleomenes (1st c. BC), Meton of Athens (5th c. BC), Martianus Capella (fl. C. 410–420), Proclus Lycaeus (412–485), Johannes Stöffler (1452–1531), Erasmus Reinhold (1511–1553), Johannes de Sacrobosco (1195–1256), Prosdocimus de Belemandis (Prodoximus, d. 1428), and Christopher Clavius (1538–1612).[331] Guarini eloquently describes the celestial sphere as a pathway of the planets and stars, serving to direct their fundamental course around the sun and its boundaries.[332]

Chapter Two of the *Compendio* begins by describing the parts of the celestial sphere, in general (*Delle Sfera, e sue parte in generale*), while the subsequent chapters describe these constituents at an increasingly greater level of intricacy.[333] Guarini discusses

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[327] Ibid., 11.
[328] Ibid., 1.; Aristotle, *Metaphysics*, trans. Richard Hope (New York: Columbia University Press, 1960), 360. The *primum mobile* is a concept presented in the *Metaphysics* as "*οθεν η αρχη τηςμ κινσεως* (*unde principium motus*), that whereby the movement is started."
[329] Ibid.
[330] Ibid.
[331] Guarini, *Compendio*, 1–2. "*Che il cielo si a rotondo, tutti li autori che scrissero della Sfera del applauso commune lo confessarono. Gemini nelli elementi Astron. Cleomene, Metala, Martiano, Proclo, Giovanni Stoeflero, Erasmo, Prodoximo, Clavio, & altri, e con ragione.*" Guarini was most likely referring to *De Motu Circulari* by Cleomenes, and to the *De nuptiis Philologiae et Mercurii*, by Martianus Capella.
[332] Ibid., 2. "*Quindi è, che per rappresentare la rotondità del Cielo, & i viaggi circolari di Pianeti gl' astronomi saggiamente habitanno inventato la Sfera, la quale non è altro, che un' intreccio materiale di diversi circoli i quali servono per rappresentare i corsi principalmente del Sole, & i suoi varij confini…*"
[333] Ibid., 2.

the celestial pole as an axis point, stating that each of the rings which the planets and stars follow along the equator, meridian, ecliptic, tropic or from orient to occident, also have an axis point of their own. The knowledge of each element containing its own axis is explained by Euclid as well (*del nostro Euclide accresciuto, spiegata la sfera*), who assigns each ring of the celestial sphere with its own set of properties through mathematical demonstration.[334] The celestial pole is the axis which determines the measurement of the sun's movement throughout the year; the position of the sun determines the shadow cast by the gnomon upon the face of the sundial or the direction of light entering the interior of the church.[335]

Each successive chapter of the *Compendio* describes the parts of the celestial sphere in increasingly greater detail. The celestial sphere that Guarini describes in *Trattato II* of the *Civile* is a more succinct, simplified version; the purpose of the *Circoli della Sfera Celeste* is didactic, intended to properly locate the site for a building and its alignment with the *angoli del mondo*.[336]

The movement of the sun throughout the year is described in Chapter Six, on the Ecliptic and the Zodiac (*Della Ecclitica, e Zodiaco*). The year is, therefore, the measurement of the movement of the sun along the ecliptic from the vantage point of the earth (*L'anno dunque, e misurato dal moto, che fa il Sole attorno il Módo per l'Ecclitica*).[337] Guarini describes the difference between the 'artificial,' and the 'natural' sphere that Passerone also discusses in his treatise, stating that the natural order of time contains twenty-four hours and both day and night. The artificial sphere is that in which we observe the sun passing above the earth, described by the hemisphere of the celestial dome (*il sole sopra alla terra, & illustra il nostro Emisfero*).[338]

Chapter Twelve (*Del loco, e grandezza respettiva della Terra*), is important to Guarini's theory of architecture as well because it describes the celestial sphere using another diagram from the *Civile*. The diagram in the *Compendio* describes the earth at the center of the celestial sphere with a vertical axis and a horizon line (*la terra dunque rispetto al Cielo, e le Sfere, e quasi un punto, & è situata almeno in quanto al sense in mezzo, e nel centro del Mondo, e massime della Sfera celeste*).[339] Defining this as a vantage point as in the explanation of the artificial sphere, he introduces a proposition first established by

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[334] Ibid., 2–3. "*Habbiamo nell' Trattato 23 del nostro Euclide accresciuto, spiegata la Sfera*…."; Guarini's reference to Euclid is from the *Phaenomena* (*φαινομενων*), an astronomical work pertaining to spherical geometry. See Euclid, *The Thirteen Books of Euclid's Elements, vol. 1*, ed. Thomas L. Heath (New York: Dover Publications, 1956), 17.; J.L. Heiberg, *Studien Über Euklid* (Leipzig: Druck und Verlag von B.G. Teubner, 1882), 50, 165.

[335] Ibid., 5. "*I circolo principali della Sfera sono dici, cioè l'Equatore, il Zodiaco, i due Coluri, l'Orizonte, il Meridiano, i due Tropici, e i due Polari, e quest, i altri sono, per cui camina il Sole, altri servono per termine, e per confine de suoi viaggi. Ponendo dunque il Sole la dove fa il giorno eguale alle notte, per esempio in H, nel quale punto fra lontano, egualméte da i polo sarà aggirandosi attorno al circolo massimo GHFZ, perche si terrà almen sensibilmente in quel giorno col suo camino in egual distanza da i poli D, & E, ma perche à poco, à poco nella successione de giorni s' accosta maggiormente, hora à questo Polo, hora a quell' altro, quindi è, che e quando al giunge all' ultima vicinanza, dopo cui comincia à ritornar in dietro…*"; Euclid, *Euclid's Elements of Geometry*, trans. E. Stone (London: John Rivington, William Johnston and Thomas Longman, 1765), 313.

[336] Guarini, *Civile*, 48.

[337] Guarini, *Compendio*, 35.

[338] Ibid.

[339] Ibid., 83.

Filolao (470–390 BC) and then by Copernicus (1473–1543), that describes the earth's revolution around the sun (*anzi la stabiliscono; perche se bene pongono, che la Terras' aggiri attorno al Sole*).[340]

The identical diagram illustrated in the *Civile* represents instructions for creating a level foundation for a building on the surface of the earth which may be aligned with the horizon (*Della maniera di livellare*). This is accomplished by hanging a lead weight (*piombo*) from what is point C (*Compendio*, point B) to point H (*Compendio*, point 6).[341] Architecturally, this establishes the plumb line of the building (*linea del piombo*); cosmologically, this vertical line represents the *axis mundi*. The measurement of right angles from the vertically hanging lead pendant creates a vertex, aligning the horizon of the building to the zenith, the vertical axis of the celestial sphere.[342]

The concluding three chapters of the *Compendio* pertain first to the subject of light and illumination and then to measurement of distances from the earth to the sun, or the earth to the planets. In Chapter Twenty-Five (*Dell'illuminatione de' Pianeti*), he refers to his discourse on light (*De Luce*) in the *Placita Philosophica*, stating that without philosophy, one cannot understand essence and substance and the light of the planets that reflect the luminous splendor of the sun (*luminose più dell'istesso splendor solare*).[343]

Chapter Sixteen, on the measurement of planets and the stars (*Della distanza, grandezza della Terra, de Cieli, e delle Stelle*), begins by assessing dubious claims about the relative size and distance of the planets. He refutes the idea that the sun is smaller than the moon, which was thought to be true, because the moon blocks out the sun during an eclipse.[344] He continues by demonstrating that the size and distance of the planets may be determined by using methods of trigonometry, also introduced by Euclid (*le quale parti sono siate dalli Astronomi osservate con l'aiuto della Trigonometria*), finally quantifying these distances using astronomy tables.[345]

The scholarly concepts are presented in the *Compendio* with a specific audience in mind. As he states in the conclusion, "without intense volition on behalf of the reader, one may gain a form of understanding beyond familiar discourse, that may also be used for any necessary academic composition."[346] The knowledge presented in the *Caelestis Mathematicae*, which would soon follow, is for a different kind of audience entirely.

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[340] Ibid.

[341] Guarini, *Civile*, 38. For the illustration of the diagram in the *Civile*, refer to Lastra I, Tratt. II, fig. 1.

[342] Guarini, *Civile*, 38–9. "*La cagione di questo si è, perche secondo che I Matematici, e la sperienza dimostrano, ogni peso si porta per la linea retta, e verticale al centro, cioè per la linea CH nella figura prima, per la qual cosa se al piombo, ò peso V pendente da N per il filo VN, ed esprimente la verticale HC la linea LN, ò IL sia normale, e ad Angoli retti nell' Orizzonete come quella, che viene al punto esistente sopra il nostro vertice, che è polo dell' Orizzonte. Essendo dunque la IL ad Angoli retti sopra la verticale CH sarà paralella, ed equidistante, secondo, che abbiamo detto al Cap. 6, Osserv. 3, Tratt. 1.*"

[343] Guarini, *Compendio*, 99.; Guarini, *Placita*, 397. "*Hîc verò, ubi inter Sphaeras atque Elementa apetitur locus, Tractatum hunc inferere volui, quòd lux tum terris, tum caelis insidiat, & utrisque regioni dominetur; & quasi vinculum & via, caelestibus terrena nectat, & tam sideribus dicatur propria, quàm Elementis.*"

[344] Guarini, *Compendio*, 106. "*Se bene si potrebbe stimat dubbioso, che il sole variasse le sue distanze al centro con il fracastore, e l'Amico, che stimo i Cieli homocentrici, no si puo però dubitare del uno, e del altre principale Pianeta; si perche la grandezza loro hor appare Maggiore, & hor Minore, & alle volte il disco solare occupa 32 m. alcune fiate 29. si come quello della Luna, alcune volte min. 35 altre m. 28.*"

[345] Ibid., 108–116.

[346] Ibid., 126. "*E questo batti per un Compendio di Sfera, e per un'erudita informatione, à chi non volendo applicarsi profondamente, desidera però haverne tal cognitione, che gli serva non solo per un familiare discorso, mà anche per ogni occorrenza di qualche Accademico componimento.*"

APPENDIX VIII

LEGES TEMPORUM ET PLANETARUM

Leges Temporum et Planetarum, published in 1678 by Augustae Taurinorum, is dedicated to Marie Jeanne-Baptiste of Savoy (1644–1724), who he refers to as *Madama Reale*, signifying the rise of the House of Savoy to kings, including her son, Victor Amadeus II (*velle enim Tabulas condere omnibus prosùs cælestium Erronum phatibus sincromas, est aurum tentare, & Sysisi saxum moliri*).[347]

The main premise of the *Leges Temporum* is that it is a record of the movement of the stars and celestial bodies based on the philosophy of the *primum mobile* of Aristotle. The concept of the *primum mobile* appears in his "first philosophy," otherwise known as the *Metaphysics*. The *mobile* or "prime mover" is the main force which moves everything in the universe. In Guarini's method of astronomical analysis and architectural theory, this force can in many ways relate to the *axis mundi*—the difference being that it is not merely thought of as a point on the earth but as a location from which this force moves the entire universe itself.

The circular and elliptical nature of Guarini's geometries that present themselves in the design of San Lorenzo are presented in the *Leges Temporum* as well (*perfectosque circulos, seu ellipses indidisse motoribus æternis conditorem iurabit*).[348] If Guarini designed San Lorenzo according to the specifications in the *Civile*, he would have used the *Temporum* to align the church to specific stellar coordinates.

[347] Guarino Guarini, *Leges Temporum et Planetarum* (unpaginated [Amici Lector]).
[348] Ibid.

APPENDIX IX

CÆLESTIS MATHEMATICAE

Cælestis Mathematicae, Pars Prima et Secunda, was published the year of Guarini's death in 1683 by the Milanese press, Ludovici Montiae. *Pars Prima* is dedicated to Francisco II d'Este, Duke of Modena from 1662 to 1694. *Pars Secunda* is dedicated to Emanuele Filiberto, Duke of Savoy from 1553 to 1580.

Pars Prima

Part One of the *Cælestis* describes the celestial sphere and the movement of the planets within its intricate design. Part Two provides a brief history and theory of gnomonics, from the horology of the sun, to the concentric delineations of measurement on the base of the sundial, a description of gnomonics in ancient Rome and Babylonia, and gnomonics as they pertain to the signs and positions of the Zodiac.

The introduction begins by welcoming Francisco II d'Este, the noble and generous Duke of Modena, to take a walk on the heavens (*caelum pedibus tuis sisto magnanime Dux*), turning as if on an axis, like a crown around the constellations (*te velut polum coronant ambitiosae constellationes*). Guarini continues on to say that "Accordingly, if the duke looking upward, admires the glorious heavens, I beg he not turn away from the emanation of the stars, but that they bestow upon him contemplation" (*siquidem si gloriosas animi tui dotes admirabundus suspicio, radio non ab astris emendicare, sed elargiri contemplor*).[349]

The *Cælestis*, as well as a number of Guarini's other treatises, place the patron of the treatise within the seat of power in the celestial sphere. Guarini humbly invites the duke to "walk on the heavens" themselves, as if the stars are not only in reach but are at his command. This relationship between astronomy and politics exists in a specific manner in the seventeenth century in the still burgeoning age of exploration. Gnomonics and the celestial sphere involve the development of cartography based on the position of the sun and the stars, as did the development of the astrolabe in the Arabic world. The knowledge of these sciences brings forth terrestrial as well as nautical discovery, which maintains a close accord with the power of the monarchy, the church, the military, and the political advancement and domination of the Savoy Dynasty and the Holy Roman Empire.

Trattato I, *Sphoera Caelestis Descripta* states the fundamentality of the sphere, the basis of astronomical examination (*sphoera utpote fundamentum, basisq; omnium, quae astronomica speculatione perlustrantur primis explicanda est*).[350] Guarini gives an abbreviated list of astronomers in history which brought forth the knowledge of the celestial sphere, including Geminus of Rhodes (1st. C. BC), Cleomenes (fl. 1st C. BC–400 BC), the Arabs of Methala (India), Martianus Capella (fl. c. 410–420), Proclus Lycaeus (412–485 AD), Stoeflerus [Johannes Stöffler] (1452–1531), Erasumus Resualdus (1511–53), Ioannes de Sacrobusco (1195–1256), Ioannes Bali [Balisterius], Prodoximus, and [Christopher] Clavius (1538–1612).

Trattato I argues against the idea of geocentrism by stating that the circular movement of the heavens is a matter of vantage point and that this creates an assumption that the sun circumnavigates the earth. It is sensed (or it appears) that the heavens move in a

[349] Guarini, *Cælestis*, (unpaginated).
[350] Guarini, *Cælestis*, 1.

circle (*Caeli motus circularis est quoad sensum*).[351] In the region in which the sun is always oblique, never passing vertically over, the stars spin in a circle around the pole (*in illis regionibus, quibus sol semper obliquus, nunquam verticalis evadit, stellae, quae circa polum torquentur, in gyrum suos motus ducunt*). At the horizon the equator completely encircles the hemisphere and fills it up, then above it, then hiding underneath, it is this circular rotation upon which the movement of the sun is determined (*aequator horizontem facit hemispherium integrum complectantur, & impleant, tum superum, tum subtùs delitescens, hinc est, quòd omnes in circulum suos motus flectere censendae sint*).[352]

Guarini argues that the stars appear to circumnavigate the earth, yet remain an equidistance apart (*stellae tum fixae, tum errantes semper cernuntur aequales*) because our vantage point is directly below the vertex of the passing stars (*quorum vertex sub illo circulo degit*), impacting our ability to perceive a change in magnitude (*inibi spectantur magnitudine differentes*).[353]

The Ptolemaic theory of eccentric planetary orbit and the Keplerian theory of elliptical orbits are verifiable, yet the inequal distance of diurnal motion and annual motion, even after much laborious research, remains open to much speculation (*speculationes plurimas ab astronomis tandem percepta*).[354] To move beyond speculation is through quantification and cognitive astronomical research to determine the dimensions of the celestial sphere (*in ipsis dimetiendis coguntur astronomi à circuli dimensionis*).[355]

Every astronomical calculation merely reveals a very small amount of movement (*omnes calculi astronomici, qui, ut experimento patescit, vix in minutis differunt à veris motibus*). Guarini's solution to this problem of calculation lies in the study of time by using a sundial (*horologia quoque sciaterica*) through a method of lines that describe the origin of the hours, months and days through the movement of intertwined circles (*lineas terminatrices describunt, ac mensum initia, dierumq; characteres, ac si motus circulo se glomerarent*).[356]

The geometric basis of the celestial sphere comes from *Tractatus XXIII* of the *Euclides*, which describes the sphere and the division of planes which intersect it.[357] In the *Cælestis*, this division of planes represents specialized astronomical properties (*nunc speciales, & caeli proprias tanquam sphoeram concepti sumo explanandas*), specifically the planets, described according to their daily and annual movement (*planetis motu, vel annuo, vel diurno*). The sphere represents a model of the heavens, divided into sections and surface planes describing this movement (*ergo ut sphaera caelum concipiendum est, & eius sectiones, divisionesq; ut superficies eam secantes*).[358]

Guarini describes a heliocentric universe; no time elapses at the location of the sun, as it is at the center of the sphere (*solis ductum eo tempore non transiret per centrum*). He describes the path of the earth around the sun (*tellureq; ea puncta quadrante*), which cre-

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[351] Guarini, *Cælestis*, 1.
[352] Ibid.
[353] Ibid.
[354] Ibid.
[355] Ibid.
[356] Ibid. Guarini's use of the word 'sciatheric' is derived from the Greek: (*σκιοθηρικος*), meaning something that belongs or relates to a sundial.
[357] Ibid., 2. "*I am Trac. 23.nostri Euclides Sphæræ…*"
[358] Ibid.

ates an insrument of light and shadow due to its angle of incidence from the sun, differentiating between the shadows which extend (*umbra styli extensa*) during the morning and evening (*instrumento spectata angulum VA7 efficiunt, & umbra matutina angulum facit cum vespertina*).[359]

As in his other treatises which involve the knowledge of the celestial sphere, Guarini carefully describes the sphere according to its components, stating that everything within the sphere passes around the center or celestial pole (*traduci semper per polos alterius*). Guarini states that the sphere is the first astronomical institution (*ex primorum astronomorum instituto*), which because of a mysterious numerical coincidence, its form embodies the 365 days of the year, in roughly three-hundred-and-sixty degrees. Guarini delineates time further into minutes (21,600) and into seconds (1,296,000), emphasizing the importance of the precise calculation of time according to the rotation of the earth and its orbit around the sun.[360]

The *axis mundi* coincides with the point in the heavens (*polo*) which creates diurnal movement (*in caelo dantur poli mundi, qui sunt puncta, super quae motus diurnus peragitur*; *linea verò polo coniugens ED mente deducta dicitur axis mundi*).[361] The circularity of the sphere signifies the journey of the planets (*cùm ergò circulos signatos itinere planetario in caelo*); the celestial pole (*polo*) is itself a consequence of this journey (*polum quoque ipsorum concipere consequentur opus fuit*).[362]

Tractatus II, The Source of Motion in Arcuate Dimensions (*Primi Mobilis Arcuus Dimensi*), is a method of measuring the curvature of the celestial sphere by configuring it within a cube (*arcuum caelestium dimensio duplex est, alia quae in sphaericis rectangulis fundatur*).[363] Guarini measures the movement of the heavens according to extension or the radians from the center of the sphere (*polo*) to the ends of an arc length, thus creating a method of triangulation within the structure of the cube (*rectangulos triangulos spectbant*).[364]

Tractatus II elaborates on a theory previously established by Ptolemy and Regiomontanus, by creating an intricate understanding of the sun's angle of coincidence upon the earth at separate locations upon the sphere which create the arc length, such as the measurement between the ecliptic and the meridian (*arcum, quem sol permeavit ab intersectione verna in ecliptica, exquirere cognitis meridiana eius declinatione, ascensione recta, aut obliquitate ecliptica*).[365]

Guarini states that every problem involving triangulation is solved by properly approaching the movement of the oblique angles created by declination, latitude and the ecliptic (*obliquangulis nituntur accedere oportet*). This primary movement (*primi mobilis*) is best determined according to the shifting distance of the terrestrial pole (*polorum mundi*).[366] Motion is determined from the position of the angle of the sun and the apparent movement of the sun according to the declination of the stars using logarithmics. However,

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[359] Ibid.
[360] Ibid.
[361] Ibid., 3. "*Linea verò polo coniugens ED mente deducta dicitur Axis Mundi.*"
[362] Ibid.
[363] Ibid., 27.
[364] Ibid., 34.
[365] Ibid.
[366] Ibid., 34.

Guarini states that the measurements determined by using angular logarithmics are lacking in accuracy (*logarithmus anguli quaesiti*).

The primary motion of the earth and the declination of heavenly bodies which surround it must be determined through a sine calculation (*logarithmi sinuum*), as the movement of the terrestrial pole (*axis mundi*; *polorum mundi*) shifts in a circle extending outward, tilting on its axis as it revolves and eccentrically orbits the sun. This sinuous movement causes the sun to appear to move throughout the year in a figure-eight motion, known as the *analemma*, discussed in Book Nine of Vitruvius and in Guarini's *Euclides* as a latitudinal diagram which shows how the length of the shadow changes with the time of year (*subiecti onibus rationes horarum erunt ex analemmatos describendae*).[367]

The next two chapters, *Tractatus III*, *Tempus Civile Distinctum* and *Tractatus IV*, *Tempus Astronomicum Animadversum*, define two different modes of thinking about time. What Guarini defines as *Tempus Civile* is the definition of time that pertains to the arrangement and structure of society (*civilibus ordinandis deservit*) and to the measurement of human labor (*humanos labores mensurat*); *Tempus Astronomicum Animadversum* is time associated with direct observation of the movement of the celestial sphere. It is an abandonment of speculation (*speculationi deservit*) for the precision of finite examination (*ideo praecifiùs, & usque ad minutias perpendemus*).[368]

Tempus Civile defines time as a product of civil accomplishment (*tempore civili agemus*), which developed according to the initial establishment of a specific society and the dissemination of its knowledge (*quorum periodi civilibus temporum initijs fixi per sequentia tempora propagantur*).[369] Numerous ancient calendars developed through this dissemination of knowledge, which Guarini summarizes in terms of history and brief calculation, including the Egyptians (*Aegyptius*), the Chaldeans (*Caldaei*), the Greeks (*Graeci*), the ancient civilzations of Mexico (*Mexicani*) and the Romans (*Romanus*).

The chronological measurement of a year is astronomically based on a complete orbit around the sun, which also coincides with the entire cycle of the Zodiac (*annus astronomicus est reditus solis ad eandem Zoiaci partem*).[370] Civilization has given rise to numerous definitions of the year and appropriated by various rulers throughout history (*haec proposito patet ex varijs annis quos sibi regna usurparunt*).[371]

The importance of *Tractatus III* and *Tractatus IV* is the careful analysis of civil and ecclesiastical time and how it directly relates to the precise chronology of the movement of the heavenly sphere and of the universe. The value of this knowledge as it pertains to the cosmology of Guarini's architecture is the pursuit of perfection in designing a building that connects civilization to cosmos, to a church that is made by the hands and minds of humankind (*humanos labores mensurat*) that connects to time in the mind of God and the universe.

Tractatus V pertains to the study of parallax (*parallaxes perquisitae*), which is fundamental in the determination of distance between the earth and the planets (*totius astro-*

367 Glare ed., *Oxford Latin Dictionary*, 1840.; See Part IV.
368 Ibid., 52, 80.
369 Ibid., 52.
370 Ibid., 53.
371 Ibid.

nomia fundamentum meritò censentur, eo quòd per eas distantia Planetarum à terra inveniantur), eclipses, the discovery of new stars, and the approach of comets (*eclipses luminarium, & novorum siderum, cometarumq; cognitionem accedemus*).[372]

The Greeks studied parallax prior to the Romans. However, the Latinists changed their mathematical measurements involving parallax from the center of the earth to the surface. This changed our understanding of locus, much like the opening of the eye upon the surface of an open fret ceiling (*aliam partis laquearis oculis suis abripere*). Guarini connects the structural network of openwork ceilings and domes to the physiological complexity of the iris as it is reflected upon the curvilinear surface of the cornea to advance the understanding of parallax, creating a syllogistic relationship between architecture, astronomy and the anatomy of the eye.

Of the variant kinds of parallax in respect to the heavens, there are eight (*species parallaxis, quae variant respectu caeli sunt octo*), a number which coincides with the octagonal shape of San Lorenzo's lantern as well as the number of catenaries in the dome.[373] Those eight species are the direct vertical measurement of the stars (*mensuraturq; circulo verticali per corps sideris*); longitude, in which one's terrestrial position changes due to their distance from the ecliptic (*quòd etiam in ea planeta situm apparenter mutet, & transferat à sua vera longitudine*); latitude, which is a necessary variable of measurement when the sun's diurnal motion is high (*motum diurnum est elevatior*) and one's position on the earth is distant from the ecliptic (*ecliptica remotior appareat, quam quòd verè sit*); the rectlinear variables of ascension (*parallaxis ascensionis rectae*), dependent upon one's position in relation to the equator and the star; the declination of parallax (*parallaxis declinationis*), because of the apparent change in altitude due to one's distance from the equator; the annual orbit of the planet, in which its movement around the sun creates successive variants in parallax (*in quo ambulat, sortiuntur, variant successivè, suam parallaxim*); distance, which can be measured from the center to the distance of what appears to be two planets, optically divided by the parallax itself (*parallaxim videntur habere duo planetae diversae remotionis à centro*); and the horizontal measurement and its variant of one's position on the earth with respect to the horizon (*est horizontalis cum variat distantia ab horizonte*).[374]

Of the variant kinds of parallax with respect to the earth, there are three (*species parallaxis respectu terrae sunt tres*): the difference between the planet and how it is observed from one's location and the distance from the center (*eadem distantia à centro*), the difference in location on the surface of the earth (*loco diverso in superficie terrae*), and the conjunction between these two variables allow for the measurement of every kind of parallax (*omnia parallaxim variare possunt*).[375]

The figures which Guarini uses to describe the effect of parallax are hemispherical, with the horizon, *axis mundi*, and the ecliptic resembling the catenaries of San Lorenzo's dome, with the earth itself at the position of the center of the dome's drum. These studies, as well as a multitude of others throughout the *Cælestis*, speak to the intricate astronomical considerations that Guarini must have had when designing San Lorenzo.

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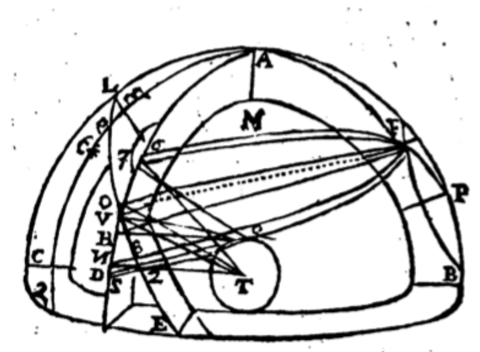
[372] Ibid., 112.
[373] Ibid., 113.
[374] Ibid.
[375] Ibid., 114.



Guarino Guarini, *Caelestis Mathematicae*, 129

Tractatus VI pertains to the discovery of astronomical refraction (*Refractiones Astronomicae Detectae*) pertains to optical refraction (*dioptricae*). Guarini states that there are a number of problems presented by refraction due to the optical density of the atmosphere of the earth (*atmosphoera vaporum*) and the visual *errata* that this may cause in observational astronomy.[376]

Tractatus VII pertains to the knowledge brought about through the work of observational astronomy (*Observationes Astrorum Opere Traditae*). The calculations of parallax and refraction are *a priori* to observation, both in practice and in the historical development of astronomy. The ability to observe the skies with solely our own eyes (*observationes ipsas astrorum oculos*) proved to be an almost insurmountable obstacle beyond the realm of mathematical calculation (*opus quidem arduum, labroribus senticorum, & diffucultatibus oppressum*).[377]

Tractatus VII also underlines several problems involving observational astronomy, including the perceptual errors caused by optical perception via the naked eye, tracing the development of observational astronomy and instrumentation, including the *Quadrante Azimutali*, *Quadrante Obliquitatem*, *Armillas Ptolemaei*, the *Siderum Locis* of Tycho Brahe, the *Cubiculo Obscuro*, and the *Thelescopij Observare* of Galileo Galilei.[378]

Guarini's discourse involving these astronomical instruments briefly outlines the formation of a more accurate system of measurement, such as determining the diameter of the sun (*diametrum solis*), the diameter of stars (*de observandis siderum diametris*) and their distance (*de siderum distantia observanda*), and several ways of determining the distance between the sun, the earth and the moon (*parallaxim solis investigare ad obtinendam eius à tellure distantiam*; *solis distantiam ex observatis diametro apparenti, umbra terrena & solis, & distantia luna à terra colligere*).[379]

Guarini describes another system of measuring the distance of the earth from the sun. Pythagoras (570–495 BC) determined that the sun is six times farther than the moon (*quam sextuplo distantiae lunae*); the theory was taken further by Aristarchus of Samos

[376] Ibid., 133.
[377] Ibid., 142.
[378] Ibid. "*Cum enim lens ex humore christalino compacta intus in oculis nostris lateat pro sua varia globositate, necesse est res alicui rapresentare maiores; quam alteri, & cum radij in foramine pupillae decussare debeant, & quò decussatio est arctior, & magis in punctum collecta, eò distinctior intuitus exerceatur, ideo necesse est observationes etiam ab ipsis oculis falli, & aliquatenùs deludi.*"; Ibid., 148, 150, 151–52, 154.
[379] Ibid., 153–58.

(310–230 BC), who was attributed with discovering the heliocentric theory, prior to Nicolas Copernicus (1473–1543).[380]

Tractatus VIII is a Description of Planetary Theories (*Theoriae Planetarum Descriptae*) and contrasts various theories of planetary movement (*motus caelestes*): eccentric (*de excentrico*), epicyclic (*de epiciclo*), excentric-epicyclic (*de epiciclo in excentricis se movente*), elliptical (*de ellipsi*), circumvolutional movement that is expressed as elliptical (*motuum caelestium ambages circulis, seu ellipsibus expressae*) and the hypothesis of terrestrial movement (*de hypotesi terrae motae*).[381]

Tractatus IX, Principles of Solar Movement (*Solis Motus Decreti*) describes the movement of the planets according to their distance, course and their orbit around the sun (*postquam situs planetarum, distantias, cursusque, et amphractus perspeximus*).[382] Guarini describes a number of hypotheses on the subject, opening the door for further research rather than inscribing a solidified theorem upon an uncertain realm of inquiry.[383]

Guarini's analysis of the celestial sphere around the sun according to the demarcations of time is an attempt at quantifying the annual cycle, which he states is equivalent to the full circumvolution of the Zodiac around the sun at the center (*annus est tempus, quo sol toto zodiaco decurso incipit idem possidere pumctum*).[384] However, Guarini also attemps to understand the physical force which moves the planets and the celestial sphere around the sun, which will in the subsequent century become one of the ultimate questions of classical mechanics. He connects the physical principle to the quantification of time, using the term *proijciantur* (to throw forth, to cast, to discharge, to scatter, to project), to describe the motion of the sun in every day and every second of the year (*omnes dies anni communis in secunda 31536000*).[385]

Guarini believes that the problem with determining the source of the sun's movement according to the principle of time (*ipsis tanquam à radice motus alijs temporibus congruos derivare possemus*) exists because the source of what we call time precedes the age of its origin (*motuum notis temporibus fixationes radices appellantur, seu epochae: quia origo sunt, ex qua alij motus procedunt*).[386]

Tractatus X, On the Stabilizing Motion of the Moon (*Lunae Motus Stabiliti*) and *Tractatus XI*, On Lunar Eclipses (*Eclipsis Lunae Demonstrata*) explain the phenomenon in which the sun coincides with the moon from the vantage point of the earth, impeding the light of the sun (*quo ita pressè copulantur planeta, ut inferior superioris lumen impediat*).[387] An eclipse occurs because of the coincidence of earth, sun and moon, of three heavenly bodies known as a *syzygia*.

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[380] Ibid., 157. Guarini specifies that Aristarchus' theory is *corroborated* by Pythagoras. (*Hic modus fuit Aristarchi Samnij, inventus, ut ostenderet Solem remouendem magis a terra, quam sextuplo distantiæ Lunæ, quod Pithagoras affirmabat.*) However, an historical discrepancy seems to exist here, because Pythagoras was born in the sixth century BC, more than two centuries prior to Aristarchus.; Copernici, *de Revolutionibus*, 134. "*Hactenus terræ circa Solem, ac Lunæ terram absolvimus revolutiones.*"
[381] Ibid., 169–190.
[382] Ibid., 192.
[383] Ibid., "*Quia verò diversis hypotesibus motus cælorum salvari poße cognovimus, quid in hæc re rationabiliùs assernendum sit hìc decernendum, electasque hypoteses numeris consentire ostendendum est.*"
[384] Ibid.
[385] Ibid., 195.; *tirare luce* (put in note here from the *Civile*), in terms of how light is thrown and pulled into the space.
[386] Ibid., 200.
[387] Ibid., 256.

Pars Secunda

Caelestis Mathematicae, *Pars Secunda*, Geometry of the Cast Shadow (*Geometricas Umbrarum*), is a brief and clear elucidation on the principles of gnomonics and its geometric foundations (*In qua tota Gnomonica à suis fundamentis clarè, delucidèq; traditur, quæ Geometria fundatur*). The figures within the treatise are intended to aptly describe what Guarini calls the heavenly bow or 'gnomon' (*arcus caelestes*) with expresses the nature of time, projected on the plate of the sundial before our eyes (*qui horologijs exprimuntur, planis sciatericis emineat, ante oculos ponitur*).[388]

Tractatus I, A Description of Astronomical Horology (*Horologia Astronomica Descripta*), provides methods and demonstrations which rely on horological diagrams. *Expensio I* provides a definition of solar horology. Guarini states that the stylus that creates the vertex of any solar clock is located the center of the earth (*in omnio horologio vertex stili fiat loco centri mundi*).[389] Guarini provides a logical explanation for this, stating that the size of the earth in comparison with respect to its orbit around the sun is like a grain of barley within a room of your house (*quale effet granum hordei in cubiculo*), making the apparent movement around it undetectable from a specific point upon the earth (*metitur semidiameter telluris, nullius momenti est comparata cum orbe solari*). Because of this, as well as the difference between the domical hemisphere of the earth, and the portion of the sky which is between the horizons which we see, what we perceive on the surface of the sundial is the movement of the stylus across the plate from the point of this immovable vertex (*transiens per verticem stili se habet*) from any point at which the sundial is on the earth.[390]

This elucidation provides a logical context for the concept of the celestial pole or the *axis mundi*, a geospatial, cosmographical concept which also represents a profound cultural, symbolic and religious meaning.[391] Like two great waves upon the ocean of the infinite, the physical, cosmographic universe collides with the cosmological in Guarini's design of San Lorenzo.

[388] Ibid., unpaginated [frontispiece].
[389] Ibid., 1.
[390] Ibid.
[391] Ibid., 3. Guarini also demonstrates the importance of cosmography within a geopolitical context when addressing his patrons. However, the geopolitical importance of San Lorenzo and its representation of the celestial sphere is also connected to cartography, exploration and conquest. This aspect of gnomonics includes the use of astrolabes and spherical astrolabes which resemble the celestial sphere and the dome of San Lorenzo.

APPENDIX X

DISSEGNI D'ARCHITETTURA CIVILE ET ECCLESIASTICA

Designs for Civil and Ecclesiastical Architecture, 1683 is primarily a series of engravings of all of Guarini's architectural projects, including those which remain unrealized. It is a precursor to the *Architettura Civile* and was possibly intended to be read as a visual companion to the book, which in the 1737 edition is only text and lacking in images.

APPENDIX XI

ARCHITETTURA CIVILE

The *Architettura Civile* was published posthumously in 1737 in Turin by the publisher Gianfrancesco Mairesse. It is dedicated to *Sua Sacra Reale Maestà*, Charles Emanuele III (1701–73), who was the ruler of Turin and the Duke of Savoy at the time of publication. The compiler and editor of the *Civile*, Provost General of the Theatines, D. Nicolaus Antinori, states his faithful adherence to Guarini's original manuscript in the preface.[392] As with Guarini's other treatises on architecture, the *Civile* is written in the vernacular.

The *Architettura Civile* contains five books: The General Principles of Architecture (*Dell'Architettura in Generale e in Suoi Principi*), Ichnography (*Della Icnografia*), Elevation (*Della Ortografia Elevata*), Orthographic Projection (*Dell'Ortografia Gettata*) and Geodesy (*Della Geodesia*). It contains forty-five tables of geometric and architectural diagrams and thirty-four tables containing the ground plans and elevations of his major works. The diagrams and tables are aligned with their corresponding description by numbers in the margin of the text. The diagrams are also subdivided into five groups that correspond to the five books of the *Civile*. The codifying structure of the treatise presents the reader with a syntactic representation of Guarini's ideas.[393] Science and mathematics are emphasized as a form of perfection that may be found in each of Guarini's great works. The *Civile* is his most comprehensive treatise on architecture, followed by the *Modo di misurare le fabbriche* and the *Trattato di fortificatione*.

The general principles of architecture are described in *Trattato I*. Guarini presents architecture as a faculty of science, and as a disciple of mathematics. Referencing Vitruvius' *De Architectura*, Guarini states that architecture is a "discipline adorned with great knowledge, of diverse erudition, that guides the creation of the other arts."[394] The arts that serve architecture, the general rules including invention, proportion, perspective, symmetry and the use of nature are discussed in Chapter Two and Chapter Three of Book One.

Guarini states that architecture is a discipline intended to be at the service of science, and at the core of that science is mathematics. Science, of all the faculties, allows us to seek our ultimate purpose, the goal of which is architecture. As Vitruvius states, [architecture] is a sophisticated science, a cognition of great discipline, and vast erudition that determines the creation of the other arts….[395]

Guarini differentiates between a form of corresponding arithmetic and numbers which are non-equivalents (*partes autem*; *cùm non metitur*). If the delineations of measurement vary from their quantitative value, then the numbers do not divide into nothing

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[392] Guarini, *Civile*, unpaginated [Facultas Reverendissimi Patris]. "*Hoc Opus inscriptum* Architettura Civile *à q. P.D. Guarino Guarino compositum, & iuxta assertionem Patrum, quibus id commissimus approbatum, ut Typis mandetur, quo ad nos spectat facultatem concedimus. In quorum sidem præsentes Litteras manu propria subscripsimus, & solito nostro Sigillo firmavimus. Romæ die 22 Octobris 1735.*"

[393] Guarini, *Civile*, xxiv. "*Il Guarini non si rassegna a ripresentare I paradigmi consueti, rispolverando prontuari presentabili, ma si sforza di estendere il repretorio grammaticale e le combinazioni sintattiche, spostando a valori massimi la gamma modulare, nell'intento tuttavia di codificare la ottenuta dilatazione per escludere ogni aggiunta non pertinente e dispersiva.*"

[394] Guarini, *Civile*, 5. *Nelle facoltà e scienze prima d'ogn'altra cosa si dee cercare il loro ultimo scopo, ed a qual fine siano indirizzate, e pertano l'Architettura, se la prendiamo come Vitruvio al lib. I, cap. I, è una scienza o cognizione ornata di più discipline, e varie erudizioni, che giudica l'opera della altre arti…*"

[395] Guarini, *Civile*, 5. "*Nelle facoltà e scienze prima d'ogn'altra cosa si dee cercare il loro ultimo scopo, ed a qual fine siano indirizzate, e pertanto l'Architettura, se la prendiamo come Vitruvio al lib. I, cap. I, è una scienza o cognizione ornata di più discipline, e varie erudizionei, che giudica l'opera della altre arti; ma se la riceviamo in più stretto significato, è una facoltà, la quale si esercita in ordinare ogni sorta di edifizi, secondo che insegna il Milliet nel suo Corso, o Mondo Matematico, tomo I, tratt. X.*"

(*metitur*), thus generating architectural space. This arithmetical relationship, which according to 'normal' calculation is inaccurate, is essential to the generation of Euclidean geometrical space and, therefore, to architecture. The non-equivalent relationship of numbers creates the propagation of space, the expansion of the indivisible point (*punctum indivisibilia*).

This relationship is evident within many of the architectural drawings and treatises of the ancient past through the Baroque period, including Guarini's *Civile*, in which he states that proportion is a correspondence between two quantities which are commensurate with one another (*proporzione è una corrispondenza de due quantità nel commensurarsi l'una coll'altra*). The two quanitites are commensurate only because they can be measured against a third, creating a spatial dimension. Referencing the Milanese architect Carlo Cesaro Osio (b. 1612), Guarini states that the creation of architectural symmetry and proportion requires an understanding of space that exists between two quantities.

Osio's treatise, also entitled *Architettura Civile* (1661), describes two arithmetical relationships involving proportion: one that is rational and another that is irrational (*ogni proportione primieramente è ò rationale, ò irrationale*). According to Osio's theory of proportion, rational proportion is combined to create their numerical equivalent. However, there is dimensional space created through the juxtaposition of unequal numerical values (*proportione poi di disuguaglianza è quella, che passa trà due quantità disuguali trà loro, come per esempio trà il 20. & il 10., trà 1'8 e il 40., ò pure trà la linea di sei palmi, e quella di due, e simili*). This theory of proportion allows for the articulation of spatial dimension used in architecture (*la proportione superarticolare*), including more complex quadratic geometries, such as the squaring of the circle or, as Osio refers to it, the proportion of the diameter of the square (*la proportione del diametro del quadrato*).

As Guarini states, the calculation of two numbers in mutual and relational measurement exists in inequality (*ratio est duorum numerorum mutua in ratione mensuratis, & mensurati relatio*). In an of itself, this relationship of numbers exists as divided from one another (*alium faltem per unitates, quae in ipso sunt, metitur*).

According to Guarini, architecture is a science because it pertains first to proportion and measurement. It is related to the other arts (sculpture, painting, metal fabrication, stone cutting), because they exist as a part of the architectural structure. The science of architecture has three parts: *edificare* (the art of building), *orologia* or *gnomonica* (the study of time and the creation of sundials), and *macchinaria* (the study of movement and equilibrium in physical bodies).[396]

These principles are also based on Vitruvius, who establishes the same principles in Book One of the *De Architectura*. These three parts, or principles, are a departure from the other architects of Guarini's time because their architecture is based, according to him, on only two principles, which are building and mechanics. These two principles have two functions: first, the creation of the idea and, secondly, the execution. The second function only serves as a mediary of the first because, as Guarini states, the architect does not build walls or roofs, but is the progenitor of the idea.[397]

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[396] Guarini, *Civile*, 6. "*L'Architettura secondo i vari generi delle fabbriche così variamente distinguesi. Vitruvio al lib. I, cap. 3, la distinse prima in tre, cioè in Arte di edificare, in Arte di fare orologi, or Gnomonica, ed in Mecanica, o Macchinaria.*"

[397] Guarini, *Civile* (Tavassi la Greca), 8–9.

According to Guarini, Vitruvius referred to the idea as synonymous with design. The idea is referred to by Vitruvius as the *dispositio*, of which there are three parts: ichnography, orthography and scenography, which pertain to the plan, elevation, and perspective. Four attributes determine architectural perfection: design, eurythmy (harmonius structure), symmetry, and distribution.[398]

There are twelve arts which serve architecture: stone cutting (*lapidaria*), statuary (*statuaria*), pottery and brick making (*la figulina*), the creation of lime mortar (*l'arte calcaria*), the plastic arts, and stucco ornamentation (*la platica*), the smithing of mechanical parts (*l'arte fabbrile*), metal fabrication (*metallica*), ironsmithing (*ferraria*), painting (*la pittura*), plumbing (*l'arte plombaria*), plaster (*l'arte dealbatoria*), and the quarrying of stone (*la pastinatoria*).

There are six other arts which serve architecture to assure that the work is done correctly. Those are: practical arithmetic (*l'aritmetica pratica*), altimetry (*l'altimetria*), planimetry (*planimetria*), geodesy (*geodesia*), stereometry (*stereometria*), and the law of servitude (*la legge de servitutibus*).

Because architecture adopts the principle of measurement, which is dependent on geometry, it is the principle of measurement that is most necessary and fundamental.[399] Guarini defines architecture as the disciple of the science of mathematics.[400] Geometry, the spatial extension of mathematics, is connected to light and to the sun. Guarini begins the *Euclides* by proclaiming that "everything in mathematics is light, a vivid source of incredible light."[401]

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[398] Ibid., 9.

[399] Guarini*,* *Civile* (Tavassi la Greca), 10.

[400] Guarini, *Civile* (*opera postuma*), 18. "*Delle operazioni per così dire infinite che i matematici vanno esercitando con evidenti dimostrazioni, ne sceglieremo alcune le più principali, che sono necessarie all'Architettura, senza però arrecare le prove, perchè questo si è proprio uffizio della Matematica, di cui l'Architettura si professa discepola*." Guarini, *Civile*, (Tavassi la Greca), 10. "*L'Architettura, sebbene dipenda dalla Matematica, nulla meno ella è un'arte adulatrice, che non vuole punto per la ragione disgustare il senso: onde sebbene molte regole sue sieguano i suoi dettami, quando però si tratta che le sue dimostrazioni osservate siano per offendere la vista, le cangia, le lascia, ed infine contradice alle medesime; onde non sarà infruttoso, per sapere quello che debba osservare l'architetto, vedere il fine dell'Architettura, ed il suo modo di procedere*." Ibid., "*Delle operazioni per così dire infinite, che i matematici vanno esercitando con evidenti dimostrazioni, ne sceglieremo alcune le più principali, che sono necessarie all'Architettura, senza però arrecare le prove, perché questo si è proprio uffizio della Matematica, di cui l'Architettura si professa discepola*.," 36.; Guarini, *Placita*, 214.; Roero, *Universal Mathematics*, 416.; Werner Müller, "The Authenticity of Guarini's Stereotomy in his "Architettura Civile" in the *Journal of the Society of Architectural Historians* 27, 3 (1968): 202.; Kruft, *Architectural Theory*, 106. "Like most theoreticians since Vitruvius, Guarini perceives architecture as a science." Vitruvius, *The Ten Books on Architecture* (Cambridge, MA: Harvard University Press, 1926), 12. "As for men upon whom nature has bestowed so much ingenuity, acuteness, and memory that they are able to have a thorough knowledge of geometry, astronomy, music and the other arts, they go beyond the functions of architects and become pure mathematicians."

[401] Guarini. *Euclides*, ("Benevolo Lectori"), unpaginated. "*Cum inter illos, qui in elementa Euclidis desudarunt, nullum intuear, unico concarcinare volumine, quæ ad quantitem sub genere investigandam faciunt, secutus seculi genium, quod centiuriat, ut plurimùm, & florilegia condit, putavi nequaquam me frugem perdere ; si huic muneri universaliùs inservirem, & Mathematica rerum exordia ex omni parte rotunda, & contornata exiberem. Siquidem ex meo labore didici, euius pretij, cuius utilitatis id operis emergat ; quod ea omnia, quæ Mathematicas luces, & euidentias in unicum lucis fontem, adeoq, solem ne dum tumultuaria collectione aglomeret ; sed etiam ordinato agmine disponat, in seriesq ; suas naturali consecutione distin-*

The sumptuousness of architectural ornamentation exists so as not to "offend the senses." However, if ornamentation is stripped away, if architecture is designed according to mathematical demonstration, it will lack refinement and will not allow one to perceive the beauty and clarity of those principles.[402] Guarini defines mathematics as the fundamental structure of the universe. Mathematics represents physicality (*edificare*), light (*orologia*, *gnomonica*) and movement (*macchinaria*) in the universe, as so it does with architecture. However, what we perceive, the beauty we experience within the universe and within a building, is not geometry itself but the brilliant luminosity of the passing sun, moving through the elegant foliations of architectonic forms.

The physicality of architecture (*le fabbriche*) is related to civic function; it is the responsibility of the architect to create a building founded upon the Vitruvian triad of solidity, functionality and elegance (*haec autem ita fieri debant ut habeatur ratio firmitatis, utilitatis, venustatis*).[403] These three principles, which are at the root of the modernist idea of form follows function, are essential, not only in Guarini's theory of architecture, but in the evolution of cartography and urban development in the city of Turin.

Guarini defends these principles by referencing the architecture treatise of his contemporary, Claude François Milliet Dechales (1611–1678), who asserts that architecture is based on ancient scientific principles, and that the invention of the contemporary architect is to create a remnant of ancient buildings according the laws of symmetry.[404] This simulacrum is based on the design of a preexistent building, as well as the geometrical symmetry of nature, aligning architecture with history and with the tangencies of cartography, geography and with the universe itself.

Chapter Four covers the instruments used in architecture: the draftsman's stylus, gum arabic and the use of a compass are described in terms of material and use. Chapter Five through Chapter Seven cover the principles of geometry and its application to built form. Chapter Eight through Chapter Ten discuss methods of proportion.

Trattato II pertains to ichnography (*Della Icnografia*). Guarini references Vitruvius Book One, Chapter One again, stating that ichnography is "that which creates an open space for the diagram of the sun" (*ex qua capiuntur in solis arearum descriptiones*). The Roman Pantheon is an example of this. A disc of light, caused by the entrance of the sun

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guat præcipué illis, qui nullo Mercurio tramitis indice, aut duce audent se huic studio consignare, & admodùm dificilem provinciam in suam sarcinam traducere." It is interesting that the mention of Mercury's transmission referenced here within the untranslated part of this quote might in fact pertain to the planet's transit over the sun in 1661. This celestial phenomenon was also observed by the astronomer and contemporary of Guarini, Christiaan Huygens. This celestial phenomenon would have also allowed for certain astronomical observations exemplified in Guarini's *Cælestis*. This reference may also be observed in note 77: Ibid., ("Benevolo Lectori"), in which "Mercury transmits no indexical path.…"

[402] Guarini, *Civile* (*opera postuma*), 3. Guarini, *Civile* (Tavassi la Greca), 10–11.

[403] Ibid., 14.; Vitruvius, *De architectura libri decem* (Venice: Franciscum Franciscum Senensem, & Ioan. Crugher Germanum, 1567), 80.; Augusto Cavallari Murat, *Forma Urbana ed Architettura nella Torino Barocca* (Torino: Unione Tipografico – Editrice Torinese, 1968), 99. "*Ciò che ai cartografi barocchi urgeva dire nella scena urbana non poteva non essere racchiuso nelle formule estetiche classiche e classicistiche; era infatti incluso nella stessa triade vitruviana* 'commodus, firmitas, venustas.'"

[404] Guarini, *Civile* (Tavassi la Greca), 16.; Claudii Francisci Milliet Dechales, *Cursus seu mundus mathematicus, tomus primus* (Lugduni: Annisonios, Joan. Pousel & Claud. Rigaud, 1690), 27. Toward the end of his life, Dechales taught mathematics at the University of Turin. Guarini's *Euclides* is referenced in Dechales' mathematics treatise *Cursus seu mundus mathematicus*, in his proemia on the progress of mathesis and the history of illustrious mathematicians.

through the great oculus of the dome moves within the interior with the shifting hours, days and months of the Roman *kalendarium*.

Guarini states that ichnography is "a description on paper of the building, and of the floor, and where it will be made, so that one's self is measured according to the building."[405] The measurement of the human form in relation to the building is also taken from anthropic measurement in Vitruvius' *De Architectura* as well as ancient precedents as far back as Genesis. The architecture theories of Alberti and Leonardo uphold the importance of the human body in relation to proportion and in the orientation of humankind at the center of all things.

Chapter One of Book Two is about levelling a building and about its placement on the horizon. The importance of this becomes clear in connection with Guarini's *Cœlestis*, as the horizon relates to astronomy and the rising of star constellations. This chapter, along with Chapter Three (*To raise sites with a magnetic compass*) and Chapter Four (*The nature of the site, and its proportion according to the angles of the world*), represent further methods of architectural orientation. Chapter Two involves the measurement of a building upon the surface and cartography of the earth but lacks the cosmological purpose of the other chapters.

Chapter Two is on measurement according to anthropic principle. Chapter Three through Chapter Five are on determining the building's location on the surface of the earth and how the sunlight and the stars will enter the building during various times during the year. Guarini connects this principle to the celestial sphere. This subject is elaborated in the *Cœlestis* as well and reveals Guarini's in-depth correlation of architecture to astronomy. Chapter Six pertains to the geometric figures which form the floorplan of the building. This is significant in the connection of the visible floorplan to the underlying geometric scheme that forms it. This underlying geometry reveals a correlation to geometric schemes in Guarini's other treatises, as well as a connection to the orthographic projection discussed in *Trattato IV*. Chapter Seven and Chapter Eight cover the general design of the floorplan, and the use of columniation in building.

Chapter Three orients the building by extending a vertical axis through it. The universal concept, known as the *axis mundi*, is representative of this kind of orientation, as it represents a cosmological center point. Guarini's chapter On Place and Void (*De Loco, et Vacuo*) in the *Placita Philosophica* describes this concept in great detail. Guarini states that "every fixed distance in space may be a location: but nonetheless, the *Polo* (the axis of the celestial sphere) is a fixed point, and just as time chooses how the heavens move, it is of the greatest significance."[406]

Book Three (*Dell'Ortografia Elevata*) discusses the elevation of the building and its geometric projection. Chapter One pertains to general principles and their application to columns, plinths and ornamentation. Chapter Two describes the use of lines, spirals, parabolas and hyperbolas in the creation of architectural forms. Chapter Three discusses the understanding of architecture through the perception of sight as opposed to the proportion of various parts. This is discussed in relation to the ancient orders of architecture and how they may be distinguished. Chapter Four delves further into the parts that constitute

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[405] Guarini, *Civile*, 63.

[406] Guarini, *Placita*, 274. "*Nota tamen, omnem distantiam fixam posse deservire pro formalitate loci: sumitur tamen, à Polo, sicut tempus desumitur à motu cœli, tanquam à puncto fixo, & magis omnibus noto.*"

those orders. Chapter Five through Thirteen describe the various orders and their measurements. Chapter Fourteen through Chapter Fifteen describes the frontispiece and methods of designing façades. Chapter Fifteen through Chapter Nineteen discuss columns and their proportions. Chapter Twenty through Chapter Twenty-Two consider the viewer's eye in relation to the perspective and proportions of the building. Chapter Twenty-Three pertains to cornices and how they are designed from an oblique perspective. Chapter Twenty-Four pertains to oblique perspective in the design of a domed building. Chapter Twenty-Five pertains to ornament and its scale. Chapter Twenty-Six pertains to vaults.

Trattato IV discusses orthographic projection (*Della Ortografia Gettata*). The perspectival planes of ichnography and elevation discussed in Book One and Book Two are brought into the third dimension in Book Four. This book must be read by connecting its principles to the other geometric demonstrations in Guarini's *Civile*. It is important to read Guarini this way, as the purpose of his demonstrations come clear through synthesis and correlation. This is true for understanding the *Civile* but also in connection to his other treatises. Together they form an interconnected body of work, a corpus that represents his world as an architect, in connection to his complex description of the universe.

Tratatto V pertains to Geodesy (*Della Geodesia*). Geodesy is the science of measuring the earth using spatial coordinate systems. Guarini's first premise pertains to the application of isoperimetrics to architecture. The isoperimetric problem is how to create an arc length of the greatest perimeter within a closed surface plane. He states that "isoperimetric figures are those which have the same circumference, that is to say enclosed with a line from the same place, so that they can make the same length…."[407]

His first proposition demonstrates the transformation of a triangle into a rectangle with the same surface area. The second proposition transforms the rectangle into a parallelogram using the same triangle. This series of propositions demonstrates the construction of a multitude of geometries generated on a surface plane.

In Chapter Eight, *Delle progressioni geometriche*, Guarini applies isoperimetry to the subject of the infinite. He discusses the rotating continuum of planes and returns to the subject of gnomonics, connecting surface plane to sphere and once again to the light of the sun. When read through, the entire book is a progression (as it is in Euclid), from point to line, surface plane to spherical form. The elegance of these demonstrations ultimately connects these geometries to the spherical form, connecting the building once again to the celestial sphere, as in *Trattato II.*

[407] Guarini, *Civile*, 414. "*Le figure isperimetre sono quelle che hanno la stessa circonferenza, cioè sono circondate da line uguali poste insieme, se sono molte fanno la stessa lunghezza….*"

BIOGRAPHICAL SKETCH

Noé Badillo was born in Ensenada, Mexico in 1978. From 2004 to 2005 he undertook an apprenticeship with the Argentinian conceptual artist and architect Osvaldo Romberg. He received his BFA in studio art in 2009 and his MA in art history in 2012 from the University of Arizona. He is a published author in the field of architectural history and theory, with a specialization on the theoretical use of light in ecclesiastical buildings. He has also exhibited his work as an artist internationally, as well as at several museums in the United States, including the Udinotti Museum of Figurative Art, the Farmington Museum of Art, the Tucson Museum of Art and the Latino Museum of Art, History and Culture in Los Angeles.