Utiles et Necessarias: Early Modern Science and the Society of Jesus

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This thesis treats of the contributions made by the Society of Jesus to Early Modern science, amidst the complexities of the post Reformation, post Copernican era. Its focus is the life and work of the Jesuit Christopher Clavius (1538-1612), the architect and founder of a mathematics academy at the Collegio Romano. Using extant correspondence, pamphlet, prefatory dedications and commentaries, I show that Clavius created a strategy to recruit and train Jesuit priests in mathematics to be exported throughout Europe and to remote missionary outposts. As a specially trained corps of priest mathematicians, the Jesuits used the truths of mathematics and the mathematical sciences to draw potential converts to the truths of faith and religious conversion. The approach was initially successful. As the scientific and religious culture shifted in the sixteenth century, however, reliance upon traditional sources of authority, knowledge and belief came under scrutiny. As priests and mathematicians who were invested in both sacred and secular realms, members of the Society struggled to adhere to the tenets of traditional natural philosophy and to promote the new sciences, for the purposes of religious conversion. The approach that substituted the truths of mathematics for the truths of dogmatic faith was intended to engender confidence. Instead it eroded their credibility, resulting in suspicion and rejection of the missionaries and their Christian faith.

Chronology

1517 ………… Luther's Ninety-five Theses sent to the Archbishop of Mainz.

1538 (c.) ……... Christopher Clavius is born

1540 ………… Society of Jesus is founded

1543 ………… Copernicus publishes *De revolutionibus*

1545 ………… Council of Trent opens

1549 ………… Francis Xavier establishes first Jesuit missionary base in Japan

1551 ………… Collegio Romano is founded

1556 ………… Death of Ignatius

1557 (c.) ……... Mathematics library at the Collegio Romano founded

1560 ………… Clavius is appointed mathematics professor at the Collegio Romano

1563 ………… Council of Trent closes

Society of Jesus granted full approval

1564 ………… Clavius' mathematics program has spread to several prominent cities

1574 ………… Society numbers more than four thousand members

1574 ………… Euclid's Elements is published for the first time

1582 ………… Gregorian Calendar Inter gravissimas

1589 ………… Galileo earns a teaching post at University of Pisa

1599 ………… Jesuit *Ratio Studiorum* is promulgated

1600 ………… East India Company established

1604 ………… Kepler's *De Stella Nova in Pede Serpentarii* published

1610 ………… Galileo publishes *Sidereus Nuncius*

1611 ………… Riccioli publishes *Almagestum Novum*

1612 ………… Death of Clavius

1614 ………… Aquaviva publishes the Ordinance for the Solidity and Uniformity of Doctrine

1615 ………… Claudio Aquaviva dies

1616 ………… First Galilean Trial

1619 ………… Bianchi's Sphaera is the first to recommend the Tychonic systme

1623 ………… Matteo Ricci's books placed on the Chinese Index of forbidden books

1632 ………… Dialogue Concerning the Two Chief World Systems

1633 ………… Condemnation of Galileo

1642 ………… Galileo dies

1644 ………… End of the Ming Dynasty

1644………… Jesuit John Adam Schall von Bell awarded for mathematical expertise by Manchu emperor

1658 ………… In 1658, Bishops Francois Pallu and Pierre Lambert de la Motte came from the papal Congregation for the Propagation of the Faith to the missions

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Introduction

The Society of Jesus ("Jesuits") was founded in 1540, twenty-three years after the Protestant Reformation and three years before Copernicus published *De revolutionibus orbium coelestium*, at a moment in history when the traditional sources of authority, knowledge and belief were undergoing widespread, radical transformation. As the Jesuit community grew from a few associates headquartered in Rome to several thousand members scattered across nearly every continent, they experienced the benefits and burdens of rapid growth. Most religious orders were struggling to regain a footing after the devastation of the Protestant Reformation[1], but the Jesuits sprang forth with vitality and zeal. The Society was marked by innovative tactics and unencumbered by the weighty tradition of more established institutions. Their contemporaries saw them as a sign of a new springtime for the Catholic Church, although often with an envious eye. As the Society of Jesus grew and began to define itself within the landscape of the post-Tridentine counter-Reformation, they assumed a role as the vanguard of certainty and confidence in the Catholic Church.

The Jesuits were approved by Pope Paul III at the Council of Trent, and soon thereafter the Society faced a challenge that would mark them for centuries to come: that of remaining committed

[1] Losses of more established religious communities such as the Benedictine, Franciscan and Dominican Orders after the Protestant Reformation were significant in number and scale. Monasteries, convents and their associated works were almost exterminated by the middle of the sixteenth century. Chapter two discusses this in greater detail.

to defending the orthodox teachings of the Catholic Church using methods and means that tested the limits of traditional praxis, in order to be seen as credible before both sacred audiences and in secular arenas. To bolster the viability of their message amidst the uncertainties of the age, members of the Society sought to secure a stable platform upon which to stand amidst a crisis of knowledge, authority, and belief. One of these platforms, the topic of this thesis, is a curious chapter in the history of the Society of Jesus. From the beginning, the Society of Jesus *successfully* employed traditional approaches to teaching and spreading the Catholic faith in Europe, Asia and the Americas. Yet in the mid-sixteenth century, they began to use mathematics and the new mathematical sciences that were emerging in that century, as a strategy for religious conversion. Central to this story is Father Christopher Clavius (d. 1612), an early member of the Society and the architect, founder and sustaining force of a mathematics academy instituted at the Jesuits' Collegio Romano in Rome. For more than fifty years, Clavius designed courses, recruited students, taught classes, secured patronage, trained professors, wrote textbooks, defended the academy against detractors and maintained a vast correspondence with leading scientists, mathematicians, patrons, prelates, kings, former students and Jesuit missionaries throughout the world. The academy was the incarnation of Clavius' vision for a world-wide network of religious priests, whose work in Europe and missionary fields would bring others to a religious conversion through mathematics and the new sciences. Clavius' genius for organization and diplomacy coupled with determination and a charismatic personality were a catalyst for the academy's immediate success.

This thesis asserts that the Jesuits' decision to found an institution solely dedicated to teaching, research and the promotion of mathematics and the new sciences was motivated primarily by a religious desire to use these disciplines to spread the Catholic faith and secure credibility for the Society of Jesus. The success of Clavius' academy did initially engender confidence in the Catholic Church and the Society, and as the academy grew, Jesuit priests trained in mathematics and the new sciences were sent throughout Europe, Asia and the Americas. Armed with mathematical textbooks, intensive preparation and mathematical accoutrements, the Jesuits were given passage into countries, cultures and continents that would have ordinarily been less than receptive to Catholicism or the arrival of a new religious order.

Mathematics and the new sciences drew the interest and admiration of intellectuals, *literati* and men of influence in Europe and abroad. Initially, the novelty of the new sciences drew the curiosity of the secular world toward the Society, and even secured converts to Christianity. But the confidence that the priest-mathematicians won for themselves through the mathematical sciences began to erode as circumstances grew more complicated in both secular and sacred realms. Concessions in the foundational mission of the Jesuits' overseas missionary enterprises in Asia and the Americas coupled with the lack of internal consensus among the Jesuits regarding the appropriate place of mathematics and the new sciences in the pedagogical formation of the Society, contributed to a diminished enthusiasm and support for Clavius' academy in Europe and abroad. Internal tension, resistance from within host cultures and increased censorship within the Church on the eve of the Galilean trials called forth new strategies amongst the Jesuit mathematicians, as Clavius and his early associates navigated the waters of a post-Reformation, post-Copernican Europe.

This thesis claims that there is a close relation between the decision of the Society of Jesus to invest in mathematics and the new sciences and the goal of religious conversion. The Jesuits' innovative approach placed priority upon mathematics and the new sciences as a guarantor of their credibility, then used that credibility to further the credibility of Christian doctrine. Ultimately, this placed them in a precarious position at a tumultuous point in history. Against the backdrop of the Reformations and the Copernican Revolution, the Jesuits sought to harmonize orthodoxy and innovation; to rely upon mathematical and scientific demonstration and adhere to belief in miracles; to have confidence in ancient sources of authority in natural philosophy and to embrace the emerging authority of the new sciences. The Jesuits faced inherent challenges in their work as Catholic priests who were at the same time practitioners of the new sciences; as a result, difficulties arose from the assumption of a dual role of priest and mathematician. Was Clavius' life-long investment in the mathematics academy at the Collegio Roman a form of scientific opportunism – a charge that has been leveled against Clavius' contemporary Galileo – or a pure manifestation of creative apostolic zeal? What is clear about Clavius is that he was an early disciple of the new sciences who was truly enamored by the beauty and order of mathematics and was convinced of its universal attraction and potential as a tool for religious conversion.

A wide body of literature has been written on the topics that are addressed in this thesis. Beginning with works written on the impact of the Jesuits from the start of the counter-Reformation until the suppression of the Jesuits in 1773 (J. O'Malley, J. Scarisbrick; G. Bailey, F. and R. Po-Hsia); Jesuit contributions to early modern mathematics and the new sciences in Europe and across multiple continents (S. Harris, M. Hellyer, M. Gorman, M. Baldwin, L. Brockey, R. Feldhay, M. Feingold); the life and work of Christopher Clavius (P. d'Elia, U. Baldini, L. Lucacs, G. Cosentino, D. Smolarski, P. Dear, W. Donahue. N. Jardine); Clavius' influence on Galileo's early thought and methodology; and the Jesuit contribution to the origins of the Scientific Revolution (A. Carugo, A. Crombie, W. Wallace, J. Pitt). This thesis contributes to previous scholarship by positioning the foundation and development of Jesuit science within the context of the profound theological and philosophical changes that were taking place in the early sixteenth century, as traditional sources of knowledge, authority and belief were under scrutiny. The circumstances surrounding the emergence of the Society as a *scholarly* religious community within the shifting epistemologies of the Reformations and the Copernican Revolution created the conditions for the Jesuits to venture further than their contemporaries had done. This thesis provides evidence that Clavius' vision for a mathematics academy and the mathematical missionaries that the academy produced extended the limits of traditional praxis. Once mobilized, Clavius' priest-mathematicians became a specialized mission field of action,[2] in response to a need for innovative strategies that Clavius believed a were necessary part of the counter- Reformation. The central themes of this thesis are limited to Clavius' distinctive contributions to a re-emergence of the field of mixed sciences that combined empirical observation with mathematical demonstration in astronomy, harmonics, optics and mechanics.[3] Clavius' contemporaries, including Galileo, made significant advances in the application of the mixed sciences throughout the sixteenth century, but their use in a field of missionary action is unique to Clavius' vision. The relationship between Galileo and the Jesuits is treated in the thesis and generally aligns with the Clavius' lifespan. Clavius died in 1612, just prior to the trials, so the Galilean controversies are intentionally not included in the scope of this paper.

The Jesuits' use of mathematics and the new sciences as primary tools for direct evangelization[4] was unprecedented and the approach was initially successful. After intensive training in mathematics and the new sciences, Clavius' mathematical missionaries went forth as he had predicted, to gain critical positions at court, to influence, convince the sceptical, draw

[2] The expression "mission field of action" is first used by Rivka Feldhay in *Galileo and the Church*: *Political Inquisition or Critical Dialogue?* (Cambridge: Cambridge University Press, 1999), 110.

[3] James Lennox, "Aristotle, Galileo and the Mixed Sciences", in *Revisiting Galileo,* William Wallace ed., (Washington DC: Catholic University Press, 1986), 31.

[4] The term "evangelization" is used throughout the thesis to encapsulate communication of the Catholic doctrine, devotion and belief.

converts to the faith and promote renewal of the Catholic faith in Europe and abroad. Ultimately, a well-intentioned strategy led to disagreement and dissention within the community and contributed to mounting suspicions among external audiences, as the Jesuits continued to cultivate this approach in Europe and the mission fields beyond the borders of Europe. The Jesuits' efforts to secure credible authority for themselves through the use of alternative means eventually compromised their credibility within the Jesuit community and among the wider Catholic communities they served.

Chapter One of this thesis establishes the social and religious context in which the Society of Jesus was founded. The challenges associated with forming a new religious order in the midst of the Reformations shaped the way that the Society interpreted the Council of Trent's mandate for religious and institutional reform of the Church. Rather than recusing themselves from potential conflict, the Jesuits positioned themselves as bearers of a credible message in matters of faith *and* science at a moment when authority, knowledge and belief in the fields of theology and natural philosophy were under critical re-evaluation, particularly in Europe. Chapter One considers this context in three ways: first, the synthesis of faith and reason prior to the Reformation and the unique tension that resulted after the Reformation; secondly, the evolving relationship among knowledge, authority and belief in medical practice as demonstrated through the early modern response of authorities to an outbreak of the plague; and thirdly, a fundamental shift in the relationship between authority and belief through the response to miracles in the fifteenth and sixteenth centuries. The Jesuits' investment in matters that were directly or indirectly related to authority, knowledge and belief in early modern Europe and their decision to embrace their religious tradition while using mathematics and the new sciences to further the cause of religion left them particularly exposed to criticism from a variety of audiences.

The second chapter describes the founding of the Society of Jesus and the broad range of important contributions of the Society toward the Catholic resurgence of the sixteenth and seventeenth centuries. The Society rapidly expanded from a small band of followers with an unspecified apostolate[5] to a multinational, highly organized, successful religious organization of men. Amidst the vagaries of the Protestant and counter-Reformations, the Jesuits' growth in membership and apostolic development, particularly in the founding of successful secondary and tertiary schools, was a surprise. As the Jesuits continued to grow in number and extend their influence far into Europe, Asia and the Americas, they were no longer a Catholic-Reformation[6] surprise but a vital source of credibility for the Catholic Church. The conviction, commitment and perseverance of the Society's members contributed greatly to the rebuilding of the Catholic Church after the Protestant Reformation. The Jesuits, and the schools they founded bolstered the confidence of prelates, kings and all who labored for the restoration of the Catholic faith.

Chapters Three and Four introduce Christopher Clavius, an early modern Jesuit who began teaching mathematics and the new sciences at the Collegio Romano in 1560. In 1579, Clavius was invited by Pope Gregory XIII to participate in the reform of the Julian calendar. The final promulgation of the reformed calendar in 1582 was contested in Protestant quarters but eventually accepted throughout Catholic and Protestant territories. The Gregorian reform bolstered the

[5] The term apostolate refers to works done by a religious community as expressions of that community's charism or purpose.

[6] Throughout the thesis I use the term Catholic Reformation rather than Counter-Reformation or Catholic Counter Reformation to refer the period of time after the Protestant Reformation when the Catholic Church implemented reforms, new structures and works in response to the Protestant Reformation. All three terms are still in current use. For the term Catholic Reformation, see John O'Malley, *Trent: What Happened at the Council* (Cambridge, Mass: Harvard University Press, 2013). Advocating use of "Counter Reformation" see Massimo Firpo, "Rethinking 'Catholic Reform' and 'Counter-Reformation': What Happened in Early Modern Catholicism-a View from Italy." *Journal of Early Modern History* 20, no. 3 (May 2016): 293–312.

credibility of the Church within and outside Catholic circles. Clavius' participation on the committee proved to be a benefit to himself and to the Society of Jesus.

In late the 1550s, Clavius established a mathematics academy at the Collegio Romano. For nearly fifty years he instructed students, wrote texts, maintained a network of patronage and advocated the place of mathematics in the Society's plan for pedagogical formation. His vision, coupled with an untiring nature, provided the impetus for his unique strategy to form priest-mathematicians at the Collegio Romano who would become "mathematical missionaries" and carry mathematics and the new sciences from Rome's epicenter to the peripheries of the world.

The structure, quality and success of the academy had no parallel in its time. The design included a central academy in Rome, but this was easily replicated and exported; as a result, new mathematical academies sprung up throughout Europe that mirrored the particular needs of local cultures. Through tireless promotion, Clavius elevated the status of mathematics from a component of the quadrivium to an independent discipline at secondary and university levels. Many eminent mathematicians who studied with Clavius went on to surpass the accomplishments of their teacher. Perhaps more importantly, the texts that Clavius produced, revised and exported throughout his long career formed the backbone of the mathematics curriculum, and their distribution extended beyond the geographical reach and lifespan of the priest-missionaries formed at the mathematics academy.

Chapter Five outlines in greater depth Clavius' vision for the use of mathematics and the new sciences in support of the Catholic faith. Throughout his vast correspondence with scientific and non-scientific audiences, prefatory dedications to rulers and benefactors, polemical pamphlets, textbook prefaces and other extant writings, several themes appear that support the premise that Clavius envisioned a strategy that would embed the study of mathematics in the Society's pedagogical framework. The second part of his strategy was the creation of a means by which Jesuit seminarians who were receiving the traditional formation in philosophy and theology would also specialize in mathematics and the new sciences, and would be sent on mission as priests and missionaries who were mathematicians and scientists.

Clavius' writings detail this twofold strategy of pedagogy and mission. His many extant works reveal several themes that are treated in chapter five: first, that mathematics is a source of certain knowledge, and even a *noble doctrine*. Mathematics, like Catholic doctrine, argued Clavius, clarifies and enlightens the mind, grounding it in stability of thought and clear judgment. Secondly, Clavius proposed that the mathematical sciences appeal to the emotive part of human nature, and that their contemplation produces a pleasing and edifying kind of contemplation. Contemplation, like doctrine, leads beyond the limits of mortality and lifts the mind and soul to infinite things. For Clavius, to contemplate the heavenly spheres was to touch the divine. The third quality of mathematics was its importance in civic affairs and its capacity to draw the attention of influential members of society. Clavius' experience with the Gregorian calendar taught him a life-lesson: mathematics and the mathematical sciences were useful in solving the problems of popes and kings. New technologies and laboratories associated with the new sciences provided opportunities for Clavius and his fellow Jesuits to host demonstrations that showcased their skill, ingenuity and the usefulness of the new sciences for prelates, kings and benefactors of the Society. The value of the new sciences in influencing polite society extended to quarters that were less receptive to Catholicism and the Jesuits. The mathematical sciences provided a neutral space where amenable conversations could take place. Throughout his career, Clavius remained in regular correspondence with scientists, mathematicians and members of the nobility which transcended confessional borders. He was convinced that men of the Society should be skilled mathematicians who were erudite in their explanations to external audiences.

Lastly, Clavius argues that the clarity and certitude of mathematics in the hands of a priest-mathematician was a powerful and effective weapon against heretics[7] who were drawing youth away from the Catholic Church. He believed that if Jesuits were fluent in answering questions of their day, especially mathematical and scientific ones, they would be a convincing force against the opponent. After a fourfold exposition of the importance and usefulness of mathematics, Clavius claims that mathematics and the new sciences were not a discipline or an academic endeavor, but a *missionary vocation*, a call within a call as a fully-fledged Jesuit. He advocated that a select few within the Society would be trained for this chosen ministry. Once trained, these missionaries would be "distributed in various nations and kingdoms like sparkling gems" whose knowledge and skill would repel enemies, draw all to the Church and be an "ornament" to the Society.

Over the course of fifty years at the Collegio Romano, the vision of Clavius was realized. It was a moment for the emergence of the mathematical sciences in general; without undervaluing the important contributions of Clavius and the Jesuits, the Scientific Revolution was a movement that existed as independent of the Society. In mid-sixteenth century Europe, the study of mathematics was gaining momentum with a new translation of Archimedes, the emergence of abacus schools and interest in oceanic navigation, to mention a few. But more importantly, mathematics and the mathematical sciences were asserting themselves as independent and necessary disciplines. Their knowledge, skill and erudition in the mathematical sciences made the Jesuits part of an important conversation that was taking place in Europe and throughout the world.

[7] This is Clavius' term.

The Jesuits' commitment to the promotion and development of the mathematical sciences met with initial success as their contributions in these fields gained respect and notoriety. The mathematical sciences explained the natural world in mathematical terms; but beyond the benefit of elucidation, their work in mathematics contributed to the growing consensus that the mathematical sciences were "useful and necessary" for society, and easily exported and adapted for practical application across a variety of cultures and languages. Mathematics provided a neutral, accessible form of communication that allowed Clavius' disciples to engage with people who would not ordinarily be receptive to the message of Christianity.

Chapters Six and Seven discuss the transition that began to take place as Clavius' mathematical missionaries became more established in Europe and in mission territories. As their message shifted from a presentation of the apparent certainty of mathematics and the new sciences to the certainty of the truths of faith, confidence amongst varied audiences listening to their message weakened. On the missions, Jesuit missionaries watched the gradual deterioration of Clavius' vision and their efforts as mathematical missionaries. The reception of Jesuit priest-mathematicians regressed and the missions that began with awe and amazement disintegrated into suspicion, mistrust and rejection within decades of their establishment.

At the same time Clavius and his academy were gaining momentum in the middle of the sixteenth century, the Society's program for intellectual and professional formation of seminarians, the *Ratio Studiorum* was being developed. Clavius insisted that mathematics and the new sciences be inserted into the traditional curriculum as an independent category of study. This created controversy in the Society. Among members of the Society, there was a lack of epistemological consensus in matters of natural philosophy and the new sciences; the continued use of Ancient and Scholastic sources provided the basis for the Society's theological framework. The displacement of ancient sources by the new sciences threatened to erode the foundational authority of traditional sources and more importantly, to reorder knowledge and a basic understanding of the natural world. The nascent Society of Jesus, founded contemporarily with the publication of Copernicus' work on heliocentrism, left them with a long and difficult predicament of choosing to maintain adherence to orthodoxy, embrace innovation or forge a third way.

As the mathematical sciences evolved and separated themselves from the tradition of natural philosophy, a tension between the two systems impacted the Society. Chapter Eight discusses a two front battle that occupied the natural philosophers and mathematicians during Clavius' lifetime and for years to follow. The first battle was an internal lack of uniformity with regard to the philosophical and theological sciences and ultimately the order of knowledge. In this context, the implementation of the final version of the 1599 *Ratio Studiorum* was met with resistance from within the community. The second battle was external, as the mathematicians and natural philosophers attempted to address the controversial questions of their day, particularly heliocentrism. Between the Galilean trials, a shift occurs as the Society's leaders implemented tighter controls and censorship in lecture halls and published texts.

The final chapter considers Clavius' mathematics academy from its inception and asks the question: why did the story take the direction that it did? The vision put forth by Clavius was unique and strategic and promised to address the greater crisis of knowledge, authority and belief in the Church and in European society. The result was the opposite; instead of unity, clarity and confidence, there was suspicion and doubt. Chapter nine looks at several disjunctions within the movement that resulted in a separation of internal and external narratives within the Society. The tightrope that Clavius walked as a conscientious preserver of tradition and a promoter of the new mathematics shifted with the generations that followed, who were less inclined to maintain a hybrid position between the old and new ways.

As priest-mathematicians, the Jesuits participated directly and indirectly to the making of the 'new man of science', whose life and vocation was dedicated to the advancement of science. This new man of science was committed to the development of sophisticated and specialized knowledge that distinguished itself from general scholarship. The knowledge acquired by the man of science was exportable, adaptable and capable of immediate application in a way unlike that of Aristotelian science. There was a cost associated with the Jesuits' investment in a specialized, sophisticated knowledge that was no longer elicited from what would have previously been considered the higher sciences of physics and metaphysics. Not only did the new mathematics gradually claim for itself greater certainty than the natural sciences, the pursuit of the mathematical sciences for their own sake marked a severance from the integrated knowledge of Ancient and Scholastic sources. Mathematical sciences replaced the Greek concept of securing demonstrative knowledge of the whole of nature, with an applied science of limited knowledge or interest in first causes.

Ten years before the release of the Gregorian calendar, the Society of Antiquaries in London published a charter and declaration of purpose. According to the Society's 1572 charter, it existed:

> [T]o contribute to *separate falsehood from truth and tradition from evidence*; to sift history by the sagacity of modern criticism, in an age wherein every part of science is advancing to perfection, and in a nation not afraid of penetrating into the remotest

> periods of their origin, or of deducting from it anything that may reflect dishonour to them.[8]

The parallel alignment of truth with evidence and falsehood with tradition in the Antiquaries' charter illustrated the belief that placing reliance upon traditional sources of authority as an endorsement of credibility demonstrated a lack of integrity and placed an obstacle to the progress of "advancing to perfection" through the sciences. By contrast, applying an undaunted criticism of tradition coupled with evidence would, according to the Society of the Antiquaries, signal the perfection and sagacity indicative of the modern age.

Clavius, a man of age, held a unique vision for the mathematics academy at the Collegio Romano. The premise of the academy embodied a conviction that reasonable men of any age, culture or state of life could be convinced of the truths of Christianity if they were first convinced of the truths of mathematics and the new sciences. The story of Clavius and his mathematics academy highlights his idealism but also the idealism of his age. It also illustrates the inherent challenges of a Jesuit priest-mathematician at the dawn of the Copernican revolution. As priests and practitioners of the new sciences, Clavius and his fellow Jesuits indefatigably invested themselves in both secular and sacred realms at a moment when these worlds were undergoing radical change.

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[8] Taken from the 1572 Charter of the Society of Antiquaries in *Archaeologia,* London, Vol. 1 (1770). Quoted in Silvio A. Bedini, Silvio A. "The Evolution of Science Museums." Technology and Culture 6, no. 1 (1965), 9 [Italics mine].

Chapter One
Jesuits in Context:
Knowledge, Authority and Belief in Early Modern Europe

The religious atmosphere in which the Society of Jesus was formed was profoundly different from the climate in which pre-Reformation religious orders began. Assumptions that were foundational to the Western understanding of nature and super-nature had fallen under intense scrutiny. The Benedictine, Franciscan and Dominican orders were established amidst difficult circumstances particular to their age and culture, but two major shifts in the sixteenth century, the Protestant Reformation and the Copernican Revolution, placed both established religious orders and newly formed foundations in an environment that was uniquely challenging. As the Jesuits were founded and began to spread throughout Europe, they found themselves situated squarely between two worlds. By vocation, the Jesuits were uniquely bound to serving the pope, to defending the authority and teachings of the Catholic Church and promoting the Church through active evangelization.[9] As *professors, scholars, administrators and founders*, the men of the Society were pressed to engage in works that would ensure a lasting reputation amongst their peers in secular society, gain the respect through intellectual and professional achievement and maintain a reputation as outstanding educators in Europe and in the mission territories.

[9] The word 'evangelization' is an ecclesial term that is used throughout the text, which means to preach the Gospel with the aim of conversion to Christianity. In the context of this thesis, the term refers specifically to work that is done to draw another to conversion to the Catholic faith.

The Jesuits' credibility in secular matters was linked to the success of their mission and played a critical role in their capacity to influence the intellectual culture of Catholic- Reformation Europe. In addition to a rigorous spiritual formation, the Society invested heavily in the professional formation of their priests, who served in a variety of secular roles not typically associated with ordained ministry, including that of mathematician and scientist. Pre- Reformation orders often supported a limited number of clerics whose teaching or research was concentrated in fields outside theology or philosophy. The Jesuits were unique in their approach of intentionally forming men to be expert in fields as varied as anthropology, medicine, politics, architecture and military science. Within this context and under the influence of Christopher Clavius, the Society committed resources to training men to be priest-mathematicians and scientists. The number of priests in the Society who were trained for this dedicated and specialized work reflects the priority the Society placed on the credibility of this approach to be effective in the secular realm.

This chapter discusses the complex circumstances in which the Society came into being amidst the intellectual and cultural shifts of sixteenth century Europe. The formation of the Jesuits and their missionary endeavors were influenced by the religious and intellectual context of the sixteenth century. Included in this consideration is the Jesuits' formation as religious priests who were prepared for preaching and administering the sacraments, but also trained as mathematicians and scientists at a time when the reliance upon traditional sources of authority was faltering. Doctrinal teachings that were central to Christianity for 1500 years were under critical reconsideration and advances in the new sciences were causing decreased confidence in ancient sources associated with natural philosophy. The medieval reliance upon natural philosophy, particularly Plato and Aristotle, to explicate and support theological principles created a complementarity between philosophy and theology that satisfied the need for language, concepts and a scaffolding for the exposition of an objective and thematically structured theology. From the thirteenth century onward, theologians used an Aristotelian framework for scriptural exegesis, the development of doctrine, teaching, clarifying and disputation.

As a centuries' old reliance upon traditional authoritative sources in natural philosophy and theology was under scrutiny in the sixteenth century, the nascent Jesuit order was faced with the difficult task of remaining firmly within their religious tradition while embracing the new sciences as part of the work of religious evangelization. Rather than leaving the practice of religion for the attractive rationality of the new sciences or functioning solely as priests who recused themselves from the potential conflict associated with the new sciences, the Jesuits remained firmly *within* their religious tradition, and used mathematics and the new sciences to *further the cause of religion*. Science was not a point of departure for the early modern Jesuit. It was a point of entry that allowed access to people and places that might have otherwise rejected the Jesuits and their message.

The first section of this chapter briefly chronicles the central relationship between reason and belief in relation to authority in pre and post Reformation Europe. Prior to the Reformation, theological and philosophical disputes were an integral part of the life of the university and the Church. After the Reformation, both Catholics and Protestants were placed in the position of having to support and defend their positions in an atmosphere that was polemically charged. The post-Reformation climate played an influential role in the Jesuits' formation. It also played a critical role shaping a post-Reformation strategy of schools and missions in Europe and eventually throughout the world.

The second section of this chapter explores the relationship between knowledge, authority and belief in the Early Modern era as demonstrated through the evolving response of authorities to an outbreak of the plague. The plague was a phenomenon that occurred frequently throughout the Middle and Early Modern periods. It was a serious and often fatal ordeal. The plague was a cause of universal concern that called forth a concerted effort on the part of civic and ecclesial leaders across all sectors of society to address the cause and alleviation of the suffering. During the early sixteenth century, remedies for the plague that had previously relied upon traditional sources of relief, namely religious devotion and intercessory prayer, were replaced by solutions from medical authority. Early modern medicine emerged as a substitute for religious devotion despite a lack of substantial proof that demonstrated the effectiveness of proposed medical remedies. In the search for relief from the plague, this new response to an outbreak in early modern society provides an illustration of the changing relationships amongst traditional authoritative sources of knowledge and belief in Early Modern Europe.

Part three of this chapter explores the relationship between authority and belief through the early modern response to miracles. This third example provides an illustration of cultural changes that were emerging amongst Protestants and Catholics as confidence in miracles and contemporary miraculous events was not only eroding but becoming a point of contention along confessional lines. In pre-Reformation Christianity, a miraculous event in the life of an individual or a community was believed to result from divine action and served as an endorsement of God's favour for the recipient and his associates. Innumerable examples of sites exist throughout Europe at which reported miracles occurred that later became places of pilgrimage and destinations for the expression of piety and devotion. Protestant Christianity was more tentative about the occurrence of miracles and the reporting of miraculous occurrences. Miracles that were recorded in the

Scriptures were reliable and worthy of belief, but miracles that occurred after the apostolic period often fell under suspicion of fabrication or were seen as an indication of a deficient faith that relied upon miracles to bolster belief among Catholics. Miraculous occurrences formed part of the fabric of the Jesuits' expression of faith. As participants and practitioners in both the natural and supernatural realms, they committed themselves to demonstrating their credibility in both worlds. Aware of the epistemological and religious tensions that marked their age, the men of the Society sought to navigate the sacred and the secular in the midst of significant cultural changes and to establish their authority as agents of the Catholic Church in a post-Reformation society.

The Council of Trent and the Society's beginnings

The Council of Trent (1545–1563) is often interpreted as a work of the post-Reformation Catholic Church flexing its authority over an already battered and worn flock. But after thirty years of bitter conflict, the opening day of the Council began inauspiciously on December 1545 with only 29 bishops and cardinals in attendance. The German bishops were conspicuously absent. Some European bishops lived in war-torn countries while others were prevented from attending because of inclement conditions. By contrast, when the Council ended 18 years later, 236 Council fathers were in attendance. Of those, two-thirds were Italian.[10] Among those assembled were four future popes who would provide continuity in the promulgation and implementation of Council decrees, but the Council itself was marked by internal clashes, entrenched bureaucracies and complex national interests.[11] These factors contributed to the final reception of the Council that

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[10] Ronnie Po-Chia Hsia, *The World of Catholic Renewal, 1540 – 1773* (Cambridge: Cambridge University Press, 1998), 15.

[11] Pope Paull III inherited the effects of the Henry VIII's *Act of Supremacy* in 1534, the sack of Rome by the troops of the Holy Roman Emperor Charles V in 1527, attacks from the French under Francis I, complications

was at times an admixture of exhaustion, apathy, cynicism, and even hostility.[12] Some, like Giovanni Strozzi, were underwhelmed by the results of the Council. He wrote to Cosimo I de' Medici in September 1562, that after examining the canons about to be approved, the general sentiment was that "to many people they [the decrees] seemed minor matters and of little importance. And many have boldly stated that major issues were promised and that this is not the reform that the world expects of this council."[13] Pressed by the reformers' accusations, the Council fathers did not attempt to reunite Christianity under one roof by trying to engage Protestants in a dialogue. Instead, they turned inward to set the house in order. Eventually, the intended effects of the Council's reform were manifest: improved clerical education and discipline; innovative missionary endeavors; and new expressions of spirituality, works of devotion, sacred music, architecture, literature and art.[14] With time, the Council's program of interior reform began to bear genuine fruit.

At the close of the Council, the Society had functioned as a community progressing through typical stages of approval for twenty-three years.[15] In the final session on the last day of the Council in December 1563, the Society of Jesus was finally approved as "a society of clerics regular for the service of the Lord and His Church."[16] The growth of the Jesuits signaled a renewed

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from within by the appointment of teenage grandchildren as cardinals including his namesake, Alessandro Farnese, threat of Ottoman Turk attack from the East; see: John W. O'Malley, *Trent*: *What Happened at the Council* (Harvard, MA: Harvard University Press, 2013), 44.

[12] Ibid, 25.

[13] Quoted in Craig A. Monson, "The Council of Trent Revisited," *Journal of the American Musicological Society* 55 (Spring, 2002): 12.

[14] Robert E. McNally, "The Council of Trent, the Spiritual Exercises and the Catholic Reform," *Church History* 34 (Mar 1965): 36.

[15] The canonical approval of a new religious order in the Catholic Church involves several stages prior to final approval. The process requires a written rule, constitutions and an expressed work of the community. An established religious community is able to operate within certain parameters as it seeks canonical approval.

[16] McNally, "The Council of Trent, the Spiritual Exercises and the Catholic Reform," 47.

vitality and hope for the work of rebuilding the Catholic Church. By the time of its final approval at the Council of Trent, the Society of Jesus already boasted several thousand members.

Knowledge, authority and belief before and after the Reformation

> [A]uthority proceeds from true reason but reason certainly does not proceed from authority. For every authority which is not upheld by true reason is seen to be weak, whereas true reason is kept firm and immutable by her own powers and does not require to be confirmed by the assent of any authority.[17]

The speaker in this passage is neither a scientist nor a natural philosopher. He is not an early modern contemporary of Christopher Clavius, but a 9th century theologian, John Scotus Eriugena (c. 877), who in this passage inverts the established relationship between knowing and believing, and places reason over traditional sources authority in the areas of Greco-Roman science, natural philosophy and the Church Fathers.

The early introduction of natural science into Christianity provided a means of incorporating explication and rational demonstration into theology. This was met with internal and external challenges. For instance, in the fifth century, Augustine of Hippo (d. 430) and the Church Fathers debated the appropriate role of reason in elucidating and clarifying the Scriptures, Catholic doctrine and belief. Augustine of Hippo's declaration, "Credo ut intelligam,"[18] articulated a foundational understanding of the Church Fathers that belief is grounded in and informed by authority, and that understanding proceeds from belief, not the converse. In an early fifth century commentary on the Book of Genesis, De *Genesi Ad Litteram* (c. 415), Augustine speaks more

[17] John Scotus Eriugena quoted in Edward Grant, *Science and Religion, 400 BC to AD 1550* (Baltimore: Johns Hopkins University, 2004), 148.

[18] Augustine of Hippo, *Tractates on the Gospel of John* in *Nicene and Post-Nicene Fathers*, ed. and trans. Philip Schaff, Vol. VII, tractate XXIX on John 7:14-18, §6 (Grand Rapids, MI: W. B. Eerdmans, 1884), 18.

directly of the relationship of faith to reason in his discourse about the form and shape of the heavens:

> Many scholars engage in lengthy discussions on these matters [the form and shape of the heavens], *but the sacred writers with their deeper wisdom have omitted them*. Such subjects are of no profit for those who seek beatitude, and, what is worse, they take up very precious time that ought to be given to what is spiritually beneficial. What concern is it of mine whether heaven is like a sphere and the earth is enclosed by it and suspended in the middle of the universe, or whether heaven like a disk above the earth covers it over on one side?[19]

Here, Augustine seems to argue more from a practical principle that it is more efficacious to use the limited amount of time human beings have on earth to seek beatitude rather than to seek explanations for things that are earthly and passing. He observes that the fulness of understanding proceeds not from human discourse but from belief that is grounded in authority. The passage continues with an admonition to withhold judgement when natural knowledge and Scripture appear to not align:

> But the credibility of Scripture is at stake, and as I have indicated more than once, there is danger that a man uninstructed in divine revelation, discovering something in Scripture or hearing from it something that seems to be at variance with the knowledge he has acquired, *may resolutely withhold his assent in other matters where Scripture presents useful admonitions, narratives, or declarations*. Hence, I must say briefly that in the matter of the shape of heaven the sacred writers knew the truth, but that the spirit of God, who spoke through them, did not wish to teach men these facts that would be of no avail for their salvation.[20]

> We do not read in the Gospel that the Lord said: "I will send you the Paraclete to teach you how the Sun and the Moon move." *Because he wished to make them Christians, not mathematicians."* Not even the "sacred writers" intended to teach anything about "the form and figure of the heavens" or about any other scientific question since "they were not useful for salvation." *De Genesi ad Litteram*[21]

[19] Augustine of Hippo, *Genesi Ad Litteram*, ed. and trans. John Hammond Taylor, Book II (New York: Paulist Press, 1983), 58.
[20] Ibid., 58.
[21] Ibid., 59.

Augustine establishes a clear order for the prioritization of knowledge, a ranking to guide sacred and secular pedagogy for the next thousand years. Exploration into the physical nature of the heavens or mathematical principles that underlie the physics of nature have a limited application to man's final destiny. Augustine does not dismiss secular knowledge and its role in guiding human affairs but demands that the things of earth be weighed in light of realities that are eternal.

In an earlier work, *On Christian Doctrine* (c. 396), Augustine cautions his flock not to seek knowledge for its own sake, but to incorporate all knowledge into the context of the divine. He states that if those "who are called philosophers happen to have said anything that is true, and agreeable to our faith … not only should we not be afraid of them, but we should even claim back for our own use what they have said, as from its unjust possessors."[22] Augustine claims the Catholic Church as a primary seat of knowledge both sacred and secular, and he encourages Christians to incorporate the truths found in secular reason to the degree that they support and uphold faith.

Six centuries later, Anselm of Canterbury (d. 1109) expressed a view similar to Augustine, placing priority upon faith as the lens that incorporates all sacred and secular understanding: "Neque enim quaero intelligere ut credam, sed credo ut intelligam."[23] Rather than being an *obstacle* to understanding, natural and supernatural knowledge is rightly ordered and fully understood through the obedience of faith. Augustine declared his primary reliance upon the Church's authority by stating that, "I would not believe in the Gospel myself if the authority of the

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[22] Augustine of Hippo, *On Christian Doctrine* in *The Works of Saint Augustine, A Translation for the 21st Century,* ed. John E. Rotelle, O.S.A.: Part I, Vol. II, *On Christian Doctrine* (Hyde Park, NY: New City Press, 1996), 159-160.

[23] Anselm of Canterbury, *Proslogium: Monologium; an Appendix, In Behalf of the Fool by Gaunilon and Cur Deus Homo*, trans. Sydney Norton Dean (Chicago: Open Court Publishing Company, 1910), 84. Translation: *I do not wish to understand in order to believe, I believe in order to understand.*

Catholic Church did not influence me to do so."[24] But a more attenuated Anselm separated the authority of Scripture from conclusions based on proof and reason. He stated that Scripture should be understood in light of *reason, experience and proof*:

> [N]othing in Scripture should be urged on the authority of Scripture itself, but that whatever the conclusion of independent investigation should declare to be true, should . . . with common proofs and with a simple argument, be briefly enforced by the cogency of reason, and plainly expounded in the light of truth.[25]

Anslem reinforced that, "common proofs and … simple argument" with the "cogency of reason" should be used to demonstrate truth, rather than a sole reliance on the "authority of Scripture itself."

John Scotus Eriugena acknowledged the limits of reason with regard to revealed and transcendent truths, as demonstrated by the mysteries of the Trinity and the Eucharist,[26] but his assertion that reason is "immutable by her own powers" and requires no assent of authority for validation foreshadows an epistemological tension characteristic of the Early Modern era. Was this medieval who placed reason over established authority an aberration, or did reason exist as an independent category by the 9th century in the West? Berengar of Tours (d. 1088), Peter Abelard (d. 1142), Adelard of Bath (d. 1152) and William of Auvergne (d. 1249) echo Eriugena's classification of logic as an autonomous tool for understanding natural and supernatural realities. Toivo Holopanienen suggests that Berengar of Tours employed reason to Christian texts to arrive at a coherent understanding of the Scriptures and the Church Fathers.[27] For these medieval philosophers, evidence was more important than authority in the proper understanding of faith.[28]

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[24] Augustine, *Contra Epistolam Manichæi Quam Vocant Fundamentum,* trans. Richard Stothert, M.A. (Grand Rapids, MI: Eerdmans Publishing Company, 1887), 5.

[25] Anselm, *Proslogium*,79.

[26] Giles Emery, *The Oxford Handbook of the Trinity* (Oxford: Oxford University Press, 2011), 161.

[27] Toivo J. Holopainen, *Dialectic and Theology in the Eleventh Century* (Leiden: E. J. Brill, 1996), 109, 116.

[28] Ed Grant, *A History of Natural Philosophy* (Cambridge: Cambridge University Press, 2007), 112.

Other commentators viewed natural philosophy as an unnecessary intrusion of limited human reason into the supernatural realm. John Damascene (d. 749) in *De Fide Orthodoxa* asserted that: "[F]aith is assent free from all meddlesome inquisitiveness,"[29] a view that was later reinforced by Hugh of St. Victor (d. 1141) and John of Salisbury (d. 1180), who supported the use of reason in the understanding of the natural order. Both parted from their contemporaries by affirming the primary authority of God in all matters of faith. John of Salisbury cited the fallibility of man's senses and erring reason, stating that these were no match for God's law and fundamental authority in matters of faith.[30]

Theology and science at the school of Chartres

Around the same time, a notable shift was taking place within the sciences with the introduction of Greek and Arabic science into western Europe. H. R. Lemay notes a movement at Chartres that signaled a challenge to the medieval concepts of structure, harmony and order in the cosmos. Here, the Church would have already had an interest in preserving the tenets of natural philosophy, which would have already engaged in the incorporation of natural philosophy as a tool for the explication of Scripture and doctrine. Prior to the twelfth century, encyclopedic works on nature and natural philosophy existed, but lacked consistent attention to detail, and were varied in accuracy and application. The introduction of Greek and Arabic science into the west in the twelfth century brought fresh challenges to traditional interpretations of Biblical and Patristic writings.[31] In commenting on the Book of Genesis, Thierry of Chartres (d. 1150) who was the chancellor at

[29] John Damascene, *De Fide Orthodoxa,* trans. Eligius M Buytaert (St. Bonaventure, N.Y: The Franciscan Institute, 1955), 208.

[30] Grant, *A History of Natural Philosophy,* 112.

[31] Helen Rodnite Lemay, "Science and Theology at Chartres: The Case of the Supracelestial Waters," *The British Journal for the History of Science,* vol. 10 no. 3, (Nov. 1977), 226.

the cathedral school of Chartres, grappled with the text of Genesis, the exegetical interpretation of the Patristic authorities and recent discoveries made in natural philosophy. He explains that in Genesis 1:6, God declares: "Let there be a firmament made amidst the waters and let it divide the waters from the waters." Thierry provides the traditional interpretation on the passage from Ambrose, Augustine, Bede and the Hexaemeral[32] literature, then begins his treatment of the passage with what he calls "physical science" as his basis, rather than beginning with the Scriptures. Thierry used human reasoning and knowledge of the physical and astronomical world available to him to explain the dynamics of God's creative act and created matter. He posits that God created matter so that it revolved in a circular manner and produced heat that heats up the air and water. This resulted in the production of water vapor that was suspended then dissolved into water drops. This mass of vaporous water reached a height of the moon and remained there as the "firmament above the waters."[33]

Surprisingly, Thierry draws his explanation from the opposite pole to what was traditional, using observation of the physical world and natural reason to explain a passage in Scripture, implying that the use of human reason aids theology in a more accurate and complete understanding of Scripture. This runs counter to Augustine's view that the fulness of understanding begins not from human observation and reason but from belief that is grounded in the authority of the Scriptures and ultimately, the Church, from which it then proceeds to reason.

William of Conches, born thirty years before Thierry of Chartres but shaped by his thought was also confronted with reconciling the new Aristotelian science in the early part of the twelfth century. He used Thierry's process of correlating physical observations of the cosmos with

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[32] Hexameral refers to the work of creation in six days according to Gen 1:1-2:3a.
[33] Ibid., 228.

Biblical interpretation. In *Philosophia mundi* (c. 1130), William of Conches rejects literal interpretations of Biblical statements that are contrary to physical laws both in Genesis 1:6 and throughout the Scriptures.[34] In *The Dragmaticon* (c. 1144), written in dialogue between a duke and a philosopher, the duke presents a traditional exegesis of the firmament above the heavens, while William of Conches takes an opposing view to the traditional interpretation of Genesis 1:6. The philosopher responds that:

> In those things which concern the Catholic faith or morals it is not permissible to contradict Bede or any of the Church fathers . . . but in matters of philosophy, if they commit any error, it is permissible to affirm the contrary. For if they were greater than us, they were nevertheless men.[35]

Here, the older man takes a bolder position on the interpretation of Genesis rather than the younger man, as the writings of William of Conches reflect a closer alignment with concepts developed in Arab-Aristotelian philosophy. The influence of Greek and Arabic science and the use of observation in exegesis of scriptural passages at Chartres in the twelfth century mirrors the challenge faced by churchmen three centuries later as prelates, natural philosophers and theologians grappled with the introduction of heliocentrism and its misalignment with key passages in the Scriptures.

For John Pecham (d. 1292) and Roger Bacon (d. 1292), natural philosophy was compatible with theology and even *necessary* for the proper understanding of religious truth and its ultimate end. "The end of true philosophy," wrote Bacon, "is to arrive at a knowledge of the Creator *from knowledge of the created world*."[36] Bacon's contemporaries, Albertus Magnus (d. 1280) and

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[34] Ibid., 231.

[35] Ibid., 231.

[36] Roger Bacon, quoted in *The Columbian Encyclopedia* (Columbia University Press, New York, 1935), 123. [Italics mine]

Thomas Aquinas (d. 1274) contributed to the view that natural philosophy and theology were distinct and complementary disciplines, while maintaining that natural and divine truths proceeded from God who is one and admits of no contradiction.

Scholars within the Catholic Church debated the proper place of reason in relation to faith until the fifteenth century when scholastic theologians became increasingly interested in speculative analysis at the expense of genuine theological development. An inclination to reduce theology to rational propositions produced a counter-reaction that was manifested in affective spiritual movements such as the *devotio moderna* that developed in the Low Countries. This shift signaled a movement from a rational and systematic approach to knowledge of divine mysteries to immediate experience and direct intuition of the Infinite. The movement towards a more devotional expression of faith gained momentum across Europe through popular works such as *The Imitation of Christ* (ca. 1420), and the writings of the Rhineland mystics Johannes Tauler (d. 1361), Henry Suso (d. 1366) and Meister Eckhart (d. 1328).[37] *Devotio moderna* remained a vital movement in Europe, especially in the Low Countries until the eve of the Protestant Reformation.

Faith and reason after the Reformation

Establishing a proportionate understanding of the relationship between faith and reason, while respecting the distinct nature of each within the context of ecclesial authority was an ongoing challenge for the Church. In the absence of a substantial threat from a competing authority within the Church, movements and counter-movements occurred regularly during the first fifteen centuries within the context of a single authority, which qualified and tempered the limits and the intensity of the debate.

[37] Elizabeth Andersen, Henrike Lahnemann, Anne Simon, *A Companion to Mysticism and Devotion in Northern Germany in the Late Middle Ages* (Boston: Brill, 2014), 235.

When the Protestant Reformation challenged the fundamental authority of the Catholic Church in matters of Scriptural interpretation, doctrine and faith, it was entirely different from the occasional medieval monk stepping out to sow his own theology. Challenges to traditional authority among Protestants and Catholics created an atmosphere of mutual intolerance that reframed the conversation of authority, knowledge and belief. A passage from John Calvin's *Institutes of the Christian Religion* provides an example of this fundamental separation in a work that attacked a core Catholic doctrine, transubstantiation:

> Hence proceeded that fictitious transubstantiation for which they fight more fiercely in the present day than for all the other articles of their faith. For the first architects of local presence could not explain, how the body of Christ could be mixed with the substance of bread, without forthwith meeting with many absurdities.
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> *Hence it was necessary to have recourse to the fiction*, that there is a conversion of the bread into body, not that properly instead of bread it becomes body, but that Christ, in order to conceal himself under the figure, reduces the substance to nothing. It is strange that they have fallen into such a degree of ignorance, nay, of stupor, as *to produce this monstrous fiction not only against Scripture, but also against the consent of the ancient Church*.[38]

Calvin challenged the Church's apparent inability to explain the doctrine of transubstantiation and accused it of resorting instead to "monstrous fiction" in the absence of a credible authority to interpret Scripture. Here Calvin introduces the notion of "generational belief," which separates the authority and belief of the ancient Church from that of the Church of the sixteenth century. He places a contemporary authority against that of the ancient Church, establishing Scripture as the final criteria and severing the continuity of belief across more than a millennium. Calvin buttresses

[38] John Calvin, *Institutes of the Christian Religion* (1536), trans. Henry Beveridge (Peabody, MA: Hendrickson Pub. Co., 2008), 1087.

his critique on his own authority and that of scripture, pitting the credible authority of the ancient Church against the dubious authority of the contemporary Catholic Church.

The Reformation and the events that occurred in its aftermath placed both established and developing churches in the precarious position of having to defend their credibility twice: first, to internal audiences searching for the certainty of truth, and second, to external audiences who were more or less sympathetic to their religious message. Domestic theological and philosophical disputes before the Reformation were an important component of university and ecclesial culture. After the Reformation, these discussions became polemically charged and public as Catholics and Protestants were pressed to define their beliefs, defend their doctrine and substantiate the credibility of their authority in matters of faith. In the absence of established authority, the place of reason once used in rational demonstration to support faith was now used to fill a void left by the absence of credible authority.

The Society of Jesus came into being at the moment when critical and rationalistic interpretations of sacred and secular knowledge were sweeping across Europe. As priests and mathematicians, they were confronted with the challenge of maintaining the continuity of both traditions, amidst the weakening of authoritative sources in natural philosophy and Catholic theology.

Knowledge, authority and belief in time of plague

The Plague defied all medicines; and the very physicians were seized with it, died with their preventives in their mouths.
- Daniel Defoe[39]

If a plague erupted in an Early Modern European city, did the town elders call the physician or the priest? In a civic crisis of magnitude, the medic and the minister were equipped with respective knowledge and both were called upon to supply either reason or faith as a viable solution. Prior to the Reformation, both had met in the public square as members of the same household, and although the solution of the priest did not always completely resonate with that of the physician, the changes that were ushered in during post Reformation Europe elevated the contest for credible knowledge, especially in moments of crisis. Tied to the outcome were social credibility, public order, and in extreme cases, death.

***Saint Sébastien* (1495). Pietro Perugino (1450-1523)**
Image : Fr. Lawrence Lew, O.P.
Used with permission.

Of all the afflictions that could befall the early modern man or woman, the plague was among the harshest. The first fourteenth centuries had drawn their own conclusions and had found

[39] Quoted in J. Foster Palmer, "Pestilences: Their Influence on the Destiny of Nations, as Shown in the History of the Plague," *Transactions of the Royal Historical Society, New Series* 1 (1883 - 1884) (Cambridge: Cambridge University Press), 259.

the solution to an outbreak generally on the spiritual plane. The medieval cure for the plague was a return to personal piety and repentance to obtain relief. Early works such as the thirteenth century *Aurea Legenda* told tales of wonder-working plague processions that cured the sick and kept diseases at bay.[40] The *Legenda* recounts that in the sixth century, Pope Gregory I carried an image of the Virgin Mary allegedly painted by Saint Luke through the streets of Rome to ask for protection against the evil that was manifested by the disease.[41] In this medieval portrait of him, the pope is shown to respond to the crisis according to a man of his times, as a prelate and a citizen of Rome who safeguarded the public welfare through an act of devotion.[42] For Christians, calling on the intercession of the saints during times of plague, sickness, and disease was authorized by the scriptural account of Christ who frequently drove out demons and diseases from those who were afflicted with physical maladies.

Martyrs were not necessarily associated with the expulsion of demons but often served as intercessory favourites because of the heroic sufferings they endured. They were also known for successfully battling paganism and heresy that were believed to draw down God's wrath. Those who nursed the victims of the plague drew consolation through the witness of the martyrs who risked their lives for others. In religious iconography, martyrs were frequently found on altarpieces, triptychs, and in shrines in a region that had been overwhelmed by sickness and despair due to the plague.[43] The connection between religious observance and health was not confined to Catholics: the Jewish poet Yehiel Mikhel castigated his plague infested community in Cracow for

[40] Jacobus de Voragine, *Legenda aurea sanctorum, sive, Lombardica historia,* trans. William Caxton (Utrecht: Johann Veldener, 1487), 113.

[41] William Granger Ryan and Eamon Duffy, "Saint Gregory" in *The Golden Legend: Readings on the Saints* (Princeton: Princeton University Press, 2012), 174.

[42] Jacobus de Voragine, 174.

[43] Christine M. Boeckl, "Giorgio Vasari's 'San Rocco Altarpiece': Tradition and Innovation in Plague Iconography," *Artibus et Historiae* 22 (2001): 34.

"neglect of Torah, swearing, greed, sharp business practices, forgery, pride, adultery, drunkenness, Sabbath-breaking, gossip, vanity, and the wearing of fine clothes."[44] Early Protestants saw the plague in a similar way: "Take away the cause and the effect will cease. When the patient becomes a penitent, see what a blessed change follows."[45] Catholics, Jews and Christians all saw affliction as an opportunity to transform their present state by acceptance and conversion, seeing illness as "a special time to see sin."[46] Even as late as the eve of the Galilean trials in May 1633, when Galileo's Florence and northern Italy were plague infested, the Italian scholar Mario Guiducci wrote to Galileo:

> In regard to health the situation is slowly improving, and there have not been as many deaths as we have written about [earlier]. This morning the Holy Madonna of Impruneta was brought to Florence, and she will stay here until Monday. The hope vested in this image, which has always been so miraculous in succoring this city, is very great, and the people have conceived the greatest hope that through the intercession of the Holy Virgin we will remain free [of the plague]. May it please the Lord God that we have prepared ourselves in such a way as not to be unworthy of so much assistance.[47]

Yet, as the plague continued to reappear throughout the late Medieval and Early Modern eras, a shift occurred in the public response to the problem as public displays of piety and devotion were replaced by rational speculation about causes and cures. As early as the fourteenth century, citizens of Florence began to move from supernatural to natural solutions for the plague. Samuel

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[44] Joseph M. Davis, *Yom-Tov Lipmann Heller: Portrait of a Seventeenth Century Rabbi* (Portland, OR: Oxford, 2005), 114.

[45] Matthew Henry, *An Exposition of All the Books of the Old and New Testaments ...: Wherein Each Chapter Is Summed Up in Its Contents: the Sacred Text Inserted at Large in Distinct Paragraphs: Largely Illustrated with Practical Remarks and Observations* (Berwick-upon-Tweed: printed by and for W. Gracie, 1807), 69.

[46] David Harley, "The Theology of Affliction and Experience of Sickness in the Godly Family, 1650-1714: The Henrys and the Newcomes," in *Religio Medici: Medicine and Religion in Seventeenth-Century England,* eds. Ole Peter Grell and Andrew Cunningham (Aldershot, UK: Scolar Press, 1996), 278.

[47] Guiducci to Galileo, 21 May 1633; *Le Opere di Galileo Galilei*, ed. Antonio Favaro, 20 vols (Firenze: Barbera, 1890-1909), vol. 15, 131, also in Richard S. Westfall. *Essays on the Trial of Galileo* (Vatican City State: Libreria Editrice Vaticana, 1989), 32.

Cohn observes that the new authority in the outbreak of a plague was no longer the priest, but the physician:

> While chroniclers in 1348 relied on the supernatural and based their explanations on the constellation of planets and bizarre happenings in distant lands, those commenting on the plague's successive bouts increasingly turned to political, social, and hygienic conditions within their own territories to understand its origins and transmission. From distrust, even hatred, of doctors during the first outbreak, *Europeans looked to the medical profession for advice and cures*, as evinced by the plague tract becoming by the beginning of the fifteenth century one of the earliest forms of popular literature in the West.[48]

The late medieval physician Jacques Despars, who was also a cleric, had a long and successful medical career and was the author of several manuals and translations, including Avicenna's *Canon*. As a priest-physician, Despars listed several possible ways of securing protection from the plague. Among these, intercessory prayer is not included. Despars reacted strongly against his contemporaries as they invoked saintly intercession and formed processions for the sick and suffering in the city. He also criticized and was deeply distressed by their preoccupation with demons and demonology.[49] As a priest and a physician, Despars challenged the traditional approach of seeking relief for the plague through intercessory prayer and instead applied to his patients the practices of contemporary medicine. Black Plague physicians Guy de Chauliac and Blasius of Barcelona (who both contracted the plague and used their experience to inform their discussion of causes and therapies), found the conventional wisdom of Galen lacking in its treatment of epidemics and diseases. Chauliac and Blasius believed that the Ancients did not have adequate experience in treating diseases like the plague because of the infrequent nature of

[48] Samuel K. Cohn, Jr., "The Black Death: End of a Paradigm," *The American Historical Review* 107 (June, 2002): 738. [Italics mine]

[49] Danielle Jacquart, "Moses, Galen and Jacques Despars: Religious Orthodoxy as a Path to Unorthodox Medical Views" in *Religion and Medicine in the Middle Ages,* eds. Peter Biller and Joseph Ziegler (Suffolk, UK: The University of York Press, 2001), 36.

outbreaks in ancient times. Treating the causes of plague as a lack of equilibrium in humors did not satisfactorily explain why victims fell to the disease while others escaped unharmed. Physicians during the Montpelier plague took the ancients' explanations into account but substituted poisonous vapors as the culprit in lieu of an imbalance of humors, believing that poisonous vapors were the mechanism for diseases that were carried across distances by hidden forces which caused contagion.[50]

Harold Cook notes a sharp distinction made between university educated physician and medical practitioners in the Middle Ages replaced by a blurring of that distinction in the Early Modern Era with the commodification of medicinal products, as disagreement arose among physicians about the medical standards that would certify true therapeutic science. An illustrative example is Thomas Sydenham, nicknamed the "English Hippocrates", who in the 1650-1660s developed the technique of a case historian, stating that the physician was to be a "natural historian of disease", which included cataloguing a history and description of diseases and using that history to perfect and stabilize the protocol and treatment.[51]

By a systematic approach grounded in disciplined observation, rather than a more philosophical approach, Sydenham was able to successfully identify and treat patients. In the example of Sydenham, there is an exchange between a primary intellectual value of truth with things that were formerly considered to be of lesser significance. Certainty, formerly rooted in principles, was now anchored in the "facts" of nature. In a reversal of the Greek and medieval reliance upon universals, in their desire for greater certainty, medical practitioners relied upon the

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[50] Melissa P. Chase, "Fevers, Poisons, and Apostemes: Authority and Experience in Montpellier Plague Treatises" in *Science and Technology in Medieval Society,* ed. Pamela O. Long (New York: New York Academy of Sciences,1976), 163.

[51] Harold J. Cook, "Physic and Natural History in Seventeenth Century England," in Revolution and Continuity: Essays in the History and Philosophy of Modern Science Peter Barker and Roger Ariew, eds, (Washington DC: CUA Press, 1991), 74.

particulars of first causes, especially at moments when reliance upon universal principles failed to produce measurable results.

Despars lacked confidence in the effectiveness of religious devotion to alleviate the plague. The Montpelier physicians, while they consulted the Ancients, gravitated toward alternative solutions that appeared to be more credible because they were grounded in observation and experience. A physician from the early fifteenth century no longer relied on the authority of religion or the Ancients for an acceptable solution to an outbreak. Instead, both departed from traditional sources of authority in favor of what they observed. Like John Scotus Eriugena at the beginning of this chapter, they inverted the relationship between authoritative knowledge and belief, replacing reliance upon authority with proofs provided by demonstration, experience and reason.

From the time of the Black Plague in c. 1348 until the plague of London in 1665, plagues continued to occur intermittently throughout Europe as physicians posited possible solutions for the affliction. Olive oil carriers' immunity to the plague led to olive oil rubbings as a preventative therapy as well as common salt, wood sorrel, tar water, coffee, vinegar, iron, and better hygiene.[52] These solutions were not only ineffective but fraught with unintended repercussions for the victims. In the unresolved search for solutions to the plague, the medical community began to shift from natural causes for the plague to the incompetence of the medical community. Dr. Hodges of London attributed the high mortality rate in times of plague to "chymists and quacks, of whose audacity and ignorance it is impossible to be altogether silent."[53] The crisis was exacerbated by

[52] Stephen R. Ell, "Iron in Two Seventeenth-Century Plague Epidemics," *Journal of Interdisciplinary History* 15 (Winter, 1985): 447.

[53] Palmer, "Pestilences: Their Influence on the Destiny of Nations, as Shown in the History of the Plague," 259.

the absence of a reliable medical authority that made it difficult to determine which doctors were practicing medicine with sufficient knowledge to actually perform procedures on patients and which were merely appropriating knowledge and skill without the credentials to do so. Burnstein relates that Queen Elizabeth's surgeon, William Clowes seemed to know: "Tinkers, Toothdrawers, Paddlers, Cattlers, Carters, Porters, Horse-gelders and Horse Leechers, Idiots, Apple-squires, Broom-men, Bawds, Witches, Conjurors, Soothsayers, and Sow-gelders, Rogues, Rat-catchers, Runagates and Procters of Spittlehouses …," all, according to Clowes, were parading about as physicians.[54] In this example, the Queen's surgeon presented himself as the authority over at least the toothdrawers, procters of spittlehouses and other suspect occupations, and placed himself as one who decided who was exercising legitimate authority and who was practicing medicine outside the established parameters of accepted medical practice. Censorship and regulation did exist within authoritative bodies of medicine lacked but consistency and was often subject to shifting social and cultural circumstances.[55] But the central question remains: who ultimately decided? Medical authorities like Despars were wary of prelates leading processions of saints during times of plague; at the same time, sixteenth century medicine lacked a legitimate authority to deal with the disparities of authentic and inauthentic practice.

The relationship between spiritual and medical authority was still evolving in the seventeenth century as seen in the example of a prior of San Marco who, despite a tide of anti-clericalism, stirred up sufficient support for a procession around the city during an outbreak of the plague. Spirituality and sanitation met in the public square as the city fathers decided that the only

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[54] Sona Rosa Burstein, "Demonology and Medicine in the Sixteenth and Seventeenth Centuries," *Folklore* (1956) 67:1,19.

[55] Lynn Thorndike, "Mediaeval Magic and Science in the Seventeenth Century," *Speculum* 28 (Oct. 1953): 695.

participants in the plague procession should be a limited number of chosen members of the clergy, the Grand Duke and a few senators. The streets were strewn with "fragrant herbs" and all citizens were kept indoors. The procession was held "at a very early hour in the morning" and "all corners of the neighboring streets were occupied by horse guards and sergeants so that nobody might pass."[56] The awkwardness of a few prelates defending their city against plague alongside civic officials who reluctantly acquiesced to the ceremony (being hard pressed for a better solution), paints a scene in miniature of the challenges the early modern prelate, the physician, and the public official faced with regard to belief, authority, and answers in time of plague.

The changes that were taking place in authoritative sources of knowledge and belief took on a new urgency in the search for a viable response to an outbreak of the plague. Confidence in the reliability of the intercession of saints and prelates to intervene in the case of an epidemic outbreak was waning at a time when unprecedented destruction overtook populations in cities and country sides. Despite its insufficiencies, the protocols of early modern medicine won out over the traditions of a previous age, and medicine advanced as a more viable solution to an outbreak of plague.

A shift within Christianity: the problem with miracles

A final exploration of the complex relationship among knowledge, authority and belief in the Early Modern era can be seen in the changing cultural response to miracles and miraculous occurrences in the sixteenth century. The Jesuits were formed at a moment when confidence in the supernatural was eroding. One of the first companions of Ignatius of Loyola, Francis Xavier,

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[56] Carlo M. Cipolla, *Faith, Reason and the Plague: A Tuscan Story of the Seventeenth Century* (Brighton, UK: Harvester Press Ltd, 1979), 9.

was renowned for his apostolic zeal and miraculous works. Francis Xavier's bull of canonization lists numerous spectacular miracles that were attributed to him by the time of his death in 1552.[57] The miracles worked by the Society's greatest missionary testify to his capacity to perform works that normally occurred outside the course of nature. The miracles also attest to the faith of those who experienced a miracle firsthand or was present at a miraculous event, and the miracles worked by Francis Xavier were a cause for celebration among the Jesuits along with those who benefited from them.

In the Protestant view, belief in contemporary miracles did not necessarily signal the divine election of an individual. On the contrary, maintaining a culture of the miraculous signaled a defective faith that required demonstration to sustain it. Miracle-dependent Catholics, observed the Protestants, relied on a fundamentally weak premise by allowing miracles in general and belief in the Eucharist in particular to occupy the center of their devotion and belief. In early sixteenth century in a letter penned to an unnamed bishop, even the Catholic Erasmus wrote, "The Christian religion nowadays does not require miracles, and there are none; but you know what lying stories are set about by crafty knaves."[58] By anchoring belief in a miraculous event that transcended rational proof or demonstration, the Catholic Church left itself exposed to accusations of naiveté, fallacy or even intention to deceive the faithful. As participants and promoters of miracles, the Jesuits' credibility and objectivity received at best, tepid reviews from their Protestant peers. In his best-selling testament *Religio Medici* (1643), the physician Sir Thomas Browne summarized the difficulty:

> Therefore, that may have some truth in it that is reported by the Jesuits of their Miracles in the Indies; I could wish it were true or had any other testimony than

[57] Francis Xavier, S.J., *Monumenta Xaveriana,* ed. Allesandro Valignano (Madrid: Typis Augustini Avrial, 1899), 713.

[58] J.A Froude, *Life and Letters of Erasmus* (London: Longmans Green, 1910), 360.

> their own Pens. They may easily believe those Miracles abroad, who daily conceive a greater at home, the transmutation of those visible elements into the Body and Blood of our Saviour.[59]

Protestant reservations about miracles stemmed in part from a predominant belief among early Protestants that the last miracle occurred with the death of St. John in the second century.[60] Alleged citing of miracles that were not recorded in the Scriptures were reduced to reasonable explanations or dismissed as confessional propaganda. The British theologian Edward Stillingfleet opined,

> What imaginable necessity or pretext can there be contrived for a power of miracles, especially among such as already own the Divine Revelation of the Scriptures? It would be otious for God to heap miracle on miracle in order to re-prove the proven, meerly for satisfaction of men's vain curiosities. [61]

The Reformers challenged Catholics to make the shift from the "evidence *of* miracles" to "evidence *for* miracles,"[62] and to provide compelling evidence that claims of miraculous occurrences were both credible and of divine origin. The post-Tridentine Church initiated a shift toward an evidentiary process that required more stringent criteria for the validation of miracles and miraculous occurrences. Daston and Park note the diminishment of religious significance upon anomalies and unusual occurrences in sixteenth century Europe. Rather than accepting anomalies

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[59] Thomas Browne, *Religio Medici* (1643) (New York: Collier, 1909), 59.

[60] Edward Stillingfleet, *Origines sacrae, or a Rational Account of the Grounds of Christian Faith, as to the Truth and Divine Authority of the Scriptures, and the matters therein contained* (London: Henry Mortlock, 1663), 140.

[61] Peter Dear, "Miracles, Experiments, and the Ordinary Course of Nature," *Isis* 81 (Dec., 1990): 670: "An example of the reduction of apparently miraculous occurrences during the period can be found in the writings of Thomas Sprat, the first chronicler of the Royal Society and an Early Modern Anglican apologist who used the imagery of dispersion to equate the diminishment of spiritual power in the early church with the physical separation of the Christians that was caused by the persecutions of Nero and Diocletian in early Rome. Sprat's main target was authority, particularly apostolic successors including the pope, who used miracles as a claim to legitimacy."

[62] Lorraine Daston, "Marvelous Facts and Miraculous Evidence in Early Modern Europe," *Critical Inquiry* 18 (Autumn, 1991), 114.

(or miracles) on blind faith, "experts" were now required to sift through the evidence.[63] In the 1650s, members of scientific communities also viewed miraculous events and associations with excessive religious devotion with caution. Thomas Sprat questioned the criteria used to assess miraculous occurrences,[64] and reliance upon authority and religious devotion was generally seen as a sign of intellectual weakness. Robert Boyle argued that the practitioner of the new sciences should "examine with more strictness and skill, than ordinary men are able, miracles, prophecies, or other proofs, said to be supernatural, that are alleged to evince a real religion" in order to understand "the certain and genuine characters of truth."[65]

Conclusion

The traditional relationship among knowledge, authority, and belief was undergoing a radical shift during the first part of the sixteenth century in Europe. Debates about the role of faith's relation to reason changed dramatically after the Protestant Reformation, with the splintering of a centralized religious authority that placed both Catholics and Protestants in a perpetually defensive position. The practical application the relationship among knowledge, authority and belief was further tested during times of plague, as spiritual traditions were replaced by solutions from medical practitioners seeking relief for the suffering. Lastly, the evolving relationship between authority and belief in response to miraculous events demonstrates a growing skepticism about the credibility of supernatural occurrences and suspicion about the integrity of those who testified to their veracity.

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[63] Katharine Park and Lorraine Daston, "Unnatural Conceptions: The Study of Monsters in Sixteenth-Century France and England," *Past and Present* 92 (1981), pp. 27.

[64] Dear, "Miracles, Experiments, and the Ordinary Course of Nature," 670.

[65] Robert Boyle, *The Christian Virtuoso, Works, V,* ed. Thomas Birch (Hildersheim: Olms, 1966), 536.

The Society of Jesus came into existence as fundamental assumptions about nature and supernature were being reconsidered. The Jesuits, invested in both natural and supernatural realms were faced with the challenge of remaining true to their commitment to defend the traditional teachings of the Catholic Church, to testify to miraculous events, and to reinforce practices of devotion as they sought to maintain credibility for both sacred and secular audiences. The Jesuits found themselves under a peculiar scrutiny as defenders and promoters of miracles and miraculous events to early modern audiences. Changes in the cultural response to miracles in the sixteenth and seventeenth centuries created challenges for the Jesuits, who as priests and practitioners of the new sciences, were heavily invested in both sacred and secular realms.

Chapter Two
From the Ashes of the Reformation:
The Catholic Reformation and the Society of Jesus

The story of the Society of Jesus is closely intertwined with the critical social, intellectual and spiritual changes of sixteenth century Europe. As noted in chapter one, baseline assumptions about the natural and supernatural world were being reevaluated as more than a millennium of thought and interpretation came under scrutiny after the Reformation. Traditional sources of authority, knowledge and belief were in a period of radical transformation across cultures, national borders and confessional lines. Under the direction of Ignatius of Loyola, the Society of Jesus was founded between the two significant events of the sixteenth century: the Protestant Reformation and the release of Copernicus' heliocentric theory. Founded in 1540, nearly twenty-five years after the publication of Martin Luther's Ninety-five Theses, and three years before the publication of his *De Revolutionibus* in 1543, the Jesuits were both shapers of and shaped by the movements of their age.

The Protestant Reformation called into question the fundamental authority of the leaders of the Catholic Church to interpret Scripture, to determine the number and kind of sacraments for Christians, and to decide upon matters of faith and doctrine. At its core, the Protestant movement and its reformers such argued that the hierarchy of the Catholic Church was an obstacle to faith, which presented a direct contrast to the Catholic understanding of the priest as mediator between God and Man. Luther proposed that the way for the Christian was an unmediated relationship between God and Man was predicated on faith.[66] A direct, unencumbered relationship, grounded in faith, was sufficient for salvation. The reformers' objections to mediated governance in ecclesial structures had a profound impact, particularly in the northern part of Europe. It also influenced the view of secular governance, as evidenced by the Protestant Hubert Languet's *Vinciciae contra tyrannos* (1579), written fifty years after the start of the Reformation. This short work envisioned a republic that was free from the meddling rule of kings and popes, where all citizens shared equal status without the complications of hierarchy or intervention of sacred and secular authority.[67]

At the near midpoint of the sixteenth century in the realm of the natural world, the publication of Copernicus' *De revolutionibus* in 1543 set off a centuries-long debate about the nature, composition and placement of the planets, stars and most significantly, the sun. In the introductory dedication to Pope Paul III, the tenuous phrase: "[W]hat I have accomplished in this regard … [I leave] to the judgement of Your Holiness in particular and of all other learned astronomers,"[68] presaged what Copernicus already knew: that his publication would challenge the fundamental premises of Greek and Scholastic natural philosophy and would cause a seismic shift in the fundamental understanding of the created world. The same pope that approved the Society of Jesus also received Copernicus' dedicated copy. Upon receipt, the pope apparently set

[66] Evidence of this can be seen in several open letters published by Martin Luther, including an "Open Letter to the Christian Nobility of the German Nation Concerning the Reform of the Christian Estate" (1520): "It is intolerable that in canon law, the freedom, person, and goods of the clergy should be given this exemption, as if the laymen were not exactly as spiritual, and as good Christians, as they, or did not equally belong to the church." "On Translation: An Open Letter" (1530). Luther, Martin, and Charles M. Jacobs. Three Treatises: [An Open Letter to the Christian Nobility of the German Nation Concerning the Reform of the Christian Estate. A Prelude to the Babylonian on Captivity of the Church. A Treatise on Christian Liberty. Introductions and Translations by C.M. Jacobs, A.T.W. Steinhaeuser and W.A. Lambert]. 1947. Also Frank Furedi. "The Invention of Individual Freedom." *History Today* 67, no. 4 (April 1, 2017): 7–8.

[67] Philippe de Mornay, *Vindiciae contra tyrannos*, *or, Concerning the legitimate power of a prince over the people, and of the people over a prince,* eds., Hubert Languet; George Garnett (Cambridge: Cambridge University Press, 1994), 65.

[68] Nicholas Copernicus, ed. Paweł Czartoryski, *Complete works [of] Nicholas Copernicus* (London: Macmillan, 1985) Preface, p, XVI.

Copernicus' treatise to the side as more pressing needs within and outside of the Church demanded his attention. The Council of Trent would begin two years later in December of 1545.

This chapter introduces the Society of Jesus as a religious order that was established in a period of revolutionary change in matters of religious faith, political rule and knowledge of the natural world. The Jesuits experienced almost immediate exponential growth throughout Europe. Their innovative approach to evangelization constituted a strategy designed to rekindle the credibility of the Catholic Church and re-establish its authority in post-Reformation Europe. Through a rigorous formation, a compelling iconographic program and bold commitment to missionary evangelization, the Jesuits were soon recognized as the vanguard of Catholic resurgence in the wake of the Protestant Reformation.

Ignatius of Loyola's sacred strategy: surprise, certainty and the early Society

We must go in by their door in order to come out by our own door.[69]
- Favourite expression of Ignatius of Loyola

The founder of the Society of Jesus, St. Ignatius of Loyola, was named Iñigo after a Castilian monk. But the registrar at the University of Paris misspelled his name and instead of the Latinized "Eneko" or "Ennecus," "Ignatius" was the new name by which he would be known to his followers and eventually the whole world.[70] Ignatius was a more universal form than his native Iberian "Iñigo." Given the borders he would cross in the days to come, a Latin form might

[69] Ignatius Loyola to Fathers Salmeron and Broet, Rome 1545, *in Letters of St. Ignatius of Loyola,* ed. William John Young (Chicago: Loyola University Press, 1959), 51.

[70] John Padberg, S.J., *Saint, Site, and Sacred Strategy: Ignatius, Rome, and Jesuit Urbanism,* ed., T. Lucas (Vatican City: Bibliotheca Apostolic Vaticana, 1995), 86.

preserve him, initially, from cultural bias. If the change in his name came as a surprise to Ignatius, it was neither the first nor the last surprise for the founder of the Society of Jesus.

With the inception of the Society of Jesus, two clear motifs arise with regard to its establishment and growth: the first motif is surprise and the second is certainty. These two attributes are not often found in combination, but in the case of the Society they mark their beginning and their ascent within the Church. The first surprise of the Society of Jesus is that it existed. Establishing a new religious community in the mid-sixteenth century was rife with challenges. In seeking to restore the Church to an earlier, more primitive expression of faith, the Reformers both in England and on the Continent had taken great pains to remove what they believed to be the excesses of the Church. The Protestant Reformers in Europe included religious orders as part of the "non-essentials"[71] of Christianity and persisted in eliminating them from the religious landscape of Europe. By the opening of Trent in 1545, most religious orders in Europe were in a total state of disarray. The more than three centuries-old Augustinian Order lost nearly all their houses in England and Germany, the Benedictines, established in the early sixth century, suffered the loss of over 800 houses, and the Franciscans and Dominicans had severe personnel and property losses as well.[72] Bringing a new religious society to birth in this climate was, at best, risky. Perhaps no one was more surprised at the Jesuits' growth than Pope Paul III, who granted the Society's approval but believed that they would not grow to more than sixty members or live much past the death of the founder.

[71] See Amy Leonard, *Nails in the Wall: Catholic Nuns in Reformation Germany* (Chicago: University of Chicago Press, 2005), 47.

[72] Ronnie Po-Chia Hsia, *The World of Catholic Renewal, 1540 – 1770* (Cambridge: Cambridge University Press, 1998), 28.

A second surprise about the Society of Jesus is their founder's use of a university system to forge a Catholic intellectual culture. The medium of the university as a means of religious or cultural formation is not surprising, but that *Ignatius*, being who he was, chose this medium for the Society is a surprise. Ignatius was not inclined to study, having left his clerical vocation early to become a soldier. When he re-entered the university, he struggled greatly as a student at the University of Paris.[73] The order founded by a man who was not naturally inclined to academic study established thirty three colleges in seven European countries by the time of his death in 1556.[74] By the time the Society was suppressed in 1773, an additional eight hundred Jesuit colleges and universities had been established throughout Europe, Asia and the Americas.[75] The Society was not originally founded to be a teaching order and there is no mention of schools in the original *Formula of the Institute*.[76] Yet within two years of their founding, the Society had instituted colleges at Padua and Coimbra that achieved immediate success.

The Jesuits' schools rapidly acquired an excellent reputation in Europe and quickly became known across various nations and cultures. They soon caught the attention of those within the Church who had already established schools prior to the Reformation. During Ignatius' lifetime a Protestant contemporary bemoaned that:

> The German College at Rome is a hotbed singularly favorable for developing the worst kind of Jesuitry. Our young Germans are educated there gratuitously; and at the end of their studies they are sent home to restore papistry to its former place and to fight for it with all their might. You find them exercising the ministry in a great number of collegiate churches and parishes. They become the advisers of bishops and even archbishops; and we see these Jesuits under our very eyes defending the Catholic cause with such zeal that we Evangelicals may well ask

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[73] Vincent Duminuco, S.J., in *Saint, Site, and Sacred Strategy: Ignatius, Rome, and Jesuit Urbanism,* ed., T. Lucas (Vatican City: Biblioteca Apostolic Vaticana, 1990), 129.

[74] Merry Wiesner-Hanks, *Early Modern Europe, 1450 – 1789* (Cambridge, UK: Cambridge University Press, 2006), 122.

[75] John O'Malley, *The First Jesuits* (Cambridge, MA: Harvard University Press, 1993), 77.

[76] Ibid., 83.

> ourselves in what lands and in what towns such fervent zeal for the beloved Gospel is found among our own party. They seduce so many souls from us that it is too distressing even to enumerate them.[77]

Ignatius' surprising decision to establish as many schools throughout Europe as possible was an important counter strategy for the Jesuits. In the early decades of the sixteenth century, Protestants had founded more than four hundred grammar schools in England alone. Schools modeled after John Calvin's College (1559) in Geneva were copied and aggressively multiplied across Protestant France and Switzerland.[78] To provide a countermeasure to the rapid spread of Protestant institutions, the Jesuits tapped wealthy patrons and engaged all the resources at their disposal to establish schools, train teachers and provide the necessary equipment to ensure that the Catholic schools were teaching doctrine but were also academically competitive against their Protestant counterparts.

As the Jesuits' credibility solidified, many royal families in Catholic France, Poland, Spain, Belgium, and Italy[79] called upon them to establish new schools or assume operation of existing schools in their territories. The Society's reputation continued to grow and as their program for the intellectual and spiritual formation of youth became known, many dioceses throughout Europe began to entrust to the Jesuits the formation of their clergy.[80] The excellence of Jesuit education elicited the admiration of their contemporaries, including Francis Bacon (d. 1626), who praised the work of the Jesuits and testified that, "When I consider their tact and ability to train up youth

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[77] Quoted from Nothgedrungene Erinnerungen in Thomas J. Campbell, *The Jesuits 1534-1921: A History of the Society of Jesus from its Foundation to the Present Time* (New York: Encyclopedia Press, 1921), 1:66.

[78] Wiesner-Hanks, *Early Modern Europe, 1450 – 1789,* 122.

[79] Martha Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century," in *Jesuit Science and the Republic of Letters,* ed. Mordechai Feingold (Cambridge, MA: MIT Press, 2003), 303.

[80] Hsia, *The World of Catholic Renewal*, 235.

in the sciences and good morals, I remember the expression of Agislaus in reference to Pharnabazus: 'Being what you are, would that you were ours.'"[81] The Protestant Dutch humanist, Hugo Grotius (d. 1645) expressed his admiration for the Society and observed that the Jesuits "had great influence in the world on account of the sanctity of their lives, and the manner in which they instruct youth in letters and the sciences."[82] Jesuit schools continued to multiply throughout Europe. Their success in the formation of Catholic youth through schools allowed the Jesuits' influence to spread rapidly within and outside the Church. Their choice of education allowed them to extend a wide reach and to make a significant contribution to the restoration of the spiritual and intellectual culture of the Church throughout Europe.

Unity, orthodoxy and the *Ratio Studiorum*

The early Jesuits used the university system to influence the secular culture and to rebuild a Catholic intellectual tradition in Europe. As Jesuit schools continued to multiply and spread across cultures, countries and even continents, the need for a single pedagogical program for the schools became necessary. In 1584, the initial draft of the *Ratio Studiorum* was created which was a pedagogical plan to address the desire for uniformity among the Society's growing network of international schools. Members of the Society met intermittently from 1582 until 1599, making modifications to the text, adding sections on rules for academic officials (one version was over 330 pages long), and appendices that addressed specific cultural requirements in the places where the Jesuits served.

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[81] Francis Bacon, *The Advancement of Learning,* eds. Peter Beal, Michael Kiernan, and Graham Rees (Oxford, UK: Clarendon Press, 2003), 17.

[82] Quoted in *Saint Ignatius and His First Companions,* ed. Charles Constantine Pise (New York: P.J. Kennedy and Sons, 1892), 20.

In 1599, the Society published the definitive version of the *Ratio Studiorum.* The final promulgation of the *Ratio* in 1599 provided a pedagogical anchor for the Society. Amidst the widespread shifts in the understanding of the natural world and the absence of a coherent and unified religious belief system, it was designed to serve as an authoritative source for the Society. The *Ratio* was the first of its kind, and it formed the Jesuit mentality and methodology in the schools.[83] It also attempted to bring a degree of doctrinal and philosophical uniformity, and a stable intellectual patrimony to the Jesuit schools.[84] The *Ratio* memorialized a systematic approach to teaching the disciplines across varied cultural circumstances.

As with the circumstances surrounding the foundation of the Society, the age in which the *Ratio* was produced made the determination of a definitive curriculum for the schools challenging. The final promulgation of the *Ratio* stood at a midway point in the cosmological revolution: fifty years before the final edition of the 1599 *Ratio*, Copernicus' *De revolutionibus* was released and thirty-five years after, Galileo was tried a second time and condemned by trial. Chapter eight will consider further how the implementation of the *Ratio* was received within the context of these significant intellectual and cultural changes, and the internal tension that developed among members of the Society over the *Ratio*, particularly in natural philosophy.

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[83] Giuseppe Cosentino, "Mathematics in the Jesuit Ratio Studiorum," in *Church, Culture, & Curriculum: Theology and Mathematics in the Jesuit Ratio Studiorum,* eds. Ladislaus Lukacs and Giuseppe Cosentino (Philadelphia: Saint Joseph's University Press, 1999), 47.

[84] Paul Richard Blum, "Benedictus Pererius: Renaissance Culture at the Origins of Jesuit Science," *Science and Education* 15 (2006): 284.

Polite society

In addition to the surprising successes of the early Society and its use of the university system to form a Catholic intellectual culture, the Jesuits possessed an additional unanticipated quality in their ability to quickly secure the confidence and esteem of influential members of society. Even as a nascent community with young members, the men of the Society were adept at navigating polite society, and they actively sought positions as court confessors, diplomats, and political advisors.[85] Members of the Society were increasingly called upon to attend to nobility and the court, and their reputation and credibility increased proportionately. Ignatius emphasized the securing of courtly appointments as an important aid in furthering the growth of the Society. A letter from Ignatius to Diego Miró in 1553 reinforced the Society's "special obligation" to serve the nobility of Europe:

> Secondly, the whole Society, ever since its beginning, is under special obligation to their highnesses, indeed, more than to any other Christian prince, whether we take into account their good works or the special love and charity, which more than anything else, ought to win over your hearts. I cannot think of any excuse that would justify our failure to serve their highnesses in a matter that is so much in keeping with our vocation, and in which they show that they will receive consolation and satisfaction of soul.[86]

Serving the Christian royalty of Europe was "much in keeping with our vocation," and Ignatius insured that the men who were recruited for the work of the Society were aptly prepared for this mission. Many recruits were born into the middle and upper classes, which was not unusual

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[85] Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century," 303.

[86] Ignatius of Loyola to Diego Miró, Rome, 1 February 1553, in *Ignatius of Loyola: Letters and Instructions*, trans. Martin E. Palmer, S.J., ed, John W. Padberg and McCarthy, John L. (Boston: Boston College Press, 2006), 112.

among religious orders but the Jesuits' intentionality in recruiting men from noble or bourgeois families separates them from their contemporaries. François de Dainville's study of the Belgian provinces between 1571 and 1586 provides an illustration: of the fifty-three novices, 15% were nobles, 50% were bourgeois or office holders, 25% were merchants and only 10% were laborers.[87] The Jesuits' emphasis on presenting an attractive public image, particularly among the educated and elite they served, is also seen in a passage from the *Constitutions* that addressed criteria for admission to the order. The *Constitutions* of 1550 discouraged potential candidates who possessed physical deformities from entering the Society. Under a section dealing with impediments to admission, "notable ugliness"[88] in the aspirant is included with the explanation that,

> It is to be noticed that persons who have notable disfigurements or defects such as humpbacks and other deformities, whether they be natural or accidental such as those from wounds and the like, *are not suitable for this Society*. For these defects are obstacles to the priesthood and do not help toward the edification of the neighbors with whom, according to our Institute, it is necessary to deal.[89]

Men who were born into socially prominent families were recruited for the Society, along with those whose appearance and ease in associating with influential audiences reflected favorably upon the Society. Men selected for the mission fields were chosen according to their capacity to uphold the image of the Society, and who would "excel in discretion and grace of conversation and (while not lacking interior qualities), have a pleasing appearance which increases their prestige…. For

[87] Francois de Dainville, *L'Éducation des jésuite : XVIe-XVIIIe siècles* (Paris: Éditions de Minuit 1978), 78.

[88] Ignatius Loyola, *The Constitutions of the Society of Jesus,* trans. George E. Ganss, S.J., (St. Louis: Institute of Jesuit Sources, 1970), Part 1, Ch. 3, on Admission to probation, #185-15. This is reinforced in a letter from Ignatius to missionaries in 1553 that states: "He should be concerned for the Society's good name and reputation and for any way in which he can further it for God's glory, chiefly through foundations (especially of colleges wherever opportunity or favorable circumstances are seen) and by recruiting good prospects for the Society, such as persons who are educated, or very active, or young, when they have good appearance, health, intelligence, good inclinations, and no apparent impediments, etc." Ignatius of Loyola: Letters and Instructions, ed. John W. Padberg, et al. St. Louis, Mo.: Institute of Jesuit Sources, 1996, "To Those Sent on Missions," pg. 393–394.

[89] Loyola, *Constitutions* #186, 52. [italics mine]

their counsel can be highly important."[90] In the selection of superiors, the 1550 *Constitutions* recommended the age and physical energy of the candidate be considered along with propriety and prestige:

> In regard to health, appearance, and age, on the one hand account should be taken of propriety and prestige, and on the other hand of the physical energies which his charge requires, that in it he may be able to fulfill his office to the glory of God our Lord. Thus, it seems that he ought to be neither very old . . . [he should possess] reputation, high esteem, and whatever else aids toward the prestige with those within and without.[91]

The social networks of the Society were not limited to men. Interactions with, and even the inclusion of women were not forbidden, and were even encouraged as a means of advancing the Society's objectives. In 1568, the Jesuit Rector Olivier Manare sent a request to General Francisco Borgia to permit "women of high rank" to enroll at the college of Paris as "these little favors for them can greatly promote our affairs."[92] The Jesuits' ranks increased as they founded schools across Europe that were known for providing an outstanding intellectual, social and spiritual formation, and the Society relied upon patrons and influential men and women to assist them in this task, and encouraged them to enroll them in their schools. In the Society's 1599 *Ratio Studiorum,* the Prefect of the Lower Studies was directed when placing seating assignments that, "Nobles are given the choicer seats."[93]

The surprising success of the early Jesuits furthered the program of Catholic renewal prescribed by the Council of Trent. Their centralized structure, bold visual contributions and

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[90] Ibid., # 624, 277.

[91] Ibid., Part VII, #732-36, 311.

[92] Olivier Manare to General Francisco Borgia, Paris, 28 August 1568. Archivum Romanum Societatis Iesu, Gallia 81, f .249. Quoted in Vincent Duminuco, *Saint, Site, and Sacred Strategy: Ignatius, Rome, and Jesuit Urbanism*, T. Lucas, ed. (Vatican City: Biblioteca Apostolic Vaticana, 1990), 392.

[93] *Ratio Studiorum*, "Rules for Prefects of the Lower School" trans. and ed. Allan P. Farrell, S.J. University of Detroit, Conference of Major Superiors of Jesuits (Washington, DC: Society of Jesus, 1970), 54, Section 29.

international missionary enterprise contributed to a second motif, of engendering confidence in sixteenth century Europe and abroad.

Bold iconography

As a driving force during the Catholic Reformation resurgence, the Jesuits' with their military character contributed to a renewed identity and a spirit of confidence in the Church. To augment the strength conveyed by their expanding ranks, the Jesuits initiated a visual program of Catholic restoration through art and architecture. Jesuit churches and schools sprang up throughout Europe and were colossal in scale, heavily ornamented and geographically central. A program of unified, iconographic structures established visual credibility for the Society and helped to secure the success of their new foundations.

Ignatius established the generalate for the Society in the heart of Rome, and from this central point Jesuit churches and schools radiated outward, dotting the landscapes of Europe, Asia and the Americas. After the Society was founded, Ignatius remained in Rome for the remainder of his sixteen-year term as superior.[94] Medieval founders regularly sought papal approval and support for their orders, but most traveled *into* Rome for ecclesiastical appointments. None lived in the shadow of St. Peter like Ignatius, who established the headquarters of the Society within four kilometres of St. Peter's Basilica. The importance of being *there*, of establishing a permanent post in the center of Rome is described in a letter from Ignatius' secretary, Juan de Polanco (1547):

> Without the connection to Rome, no matter how much the Society was to increase in numbers, things would surely go badly for its preservation. For this reason, those

[94] John O' Malley in *The Jesuits: Cultures, Sciences, and the Arts, 1540 – 1773,* J. O'Malley, G. Bailey, S. Harris, T. Kennedy, eds., (Toronto: University of Toronto Press, 1999), 210.

> who know the importance of this house in Rome most reasonably want to know what is going on in it. [95]

The Jesuits' foundational church, the Gesù, was geographically situated near the pope and the Campidoglio on the west side. During the second half of the sixteenth century, the pope ceded this part of Rome to the Jesuits to maximize the effect of their religious presence, placing them between St. Peter's and the church of St. John Lateran.[96] A map entitled "Roma Ignatiana" shows the Gesù positioned at this pole in the center of Rome. The Gesù's wide portal that opened to the world introduced what was considered to be among the first works of triumphal architecture in Catholic Reformation Rome[97] (fig.1). The conceptual plan for the Gesù was drawn up by Ignatius in 1551, eleven years after the Society was founded. The nave was constructed so that upon entry, the visitors' eye would immediately fall upon the sanctuary that enshrined the Eucharist, located immediately below an emblem bearing the Society's motto. The Gesù gave testimony to the apologetic, missionary emphasis of the Society: the window glass was clear, not stained, for reading, while the ambo was elevated and situated to the left to emphasize the

Figure 1: The Church of the Gesù, Rome. Source: Fr. Lawrence Lew. Used with permission.

[95] Juan de Polanco to Antonio Araoz, 31 October 1547, *Epistolae et Instructiones S. Ignatii de Loyola* in *Monumenta Historica Societatis Iesu*, (Rome: Institutum Historicum Societatis Iesu, 1982): I, 208. Quoted in Vincent Duminuco, Saint, Site, and Sacred Strategy: Ignatius, Rome, and Jesuit Urbanism, T. Lucas, ed. (Vatican City: Biblioteca Apostolic Vaticana, 1990), 394.

[96] Evonne Levy, "A Noble Medly and Concert of Materials and Artifice: Jesuit Church Interiors in Rome, 1567 – 1700," in *Saint, Site, and Sacred Strategy: Ignatius, Rome, and Jesuit Urbanism,* ed. T. Lucas (Vatican City: Biblioteca Apostolic Vaticana, 1990), 41.

[97] Ibid., 53.

Scriptural defense of the faith.[98] The Gesù shared the same didactic ends as the cathedrals of Chartres or Saint-Denis, but the stucco figures along the nave that marked out the geographical domains of the Society elicited a different kind of instruction.[99] The Gesù's colossal bearing; iconographic emphasis on the Eucharist, a source of bitter division among Catholics and Protestants; and the motif of global exploration articulated the bold confidence of the early Society.

Although Jesuit priests were not committed to any particular style of external dress, their unique program of art and architecture was extensive enough to earn the term, "Jesuit style," which appeared in Europe around the beginning of the seventeenth century. Thomas Buser and Evonne Levy observe that the Jesuits' buildings and restoration plans were part of an urban renewal project, a "conscious aesthetic program" designed to give Catholic Europe a facelift.[100] The expense incurred with the building and renovation of great structures such as the Gesù in Rome required wealthy patrons like the Farnese family, whose support heavily influenced the architecture and adornment of Jesuit structures. In the case of the Church of the Gesù it was not only the Farnese patrons of Rome, but also Cardinal Alessandro (Farnese) who insisted that a church be characterized by its *magnificenza.*[101]

If a society legitimates itself by its colossal architecture, then Ignatius and his company made no small contribution to the narrative that all was not lost in Catholic Rome. Deliberations about the design and material of the church signaled the early Jesuits' main concern that the

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[98] Robert S. Miola, *Early Modern Catholicism: An Anthology of Primary Sources* (Oxford: Oxford University Press, 2007), 14.

[99] Levy, "A Noble Medly and Concert of Materials and Artifice: Jesuit Church Interiors in Rome, 1567 – 1700," 53.

[100] Thomas Buser, "Jerome Nadal and Early Jesuit Art in Rome," *Art Bulletin* 58 (1976): 424.

[101] Clare Robertson, "Two Farnese Cardinals and the Question of Jesuit Taste," in *The Jesuits: Cultures, Sciences, and the Arts, 1540 – 1773,* eds. J. O'Malley, G. Bailey, S. Harris, T. Kennedy (Toronto: University of Toronto Press, 1999), 144.

"chapel convey magnificence and without apology" and that "the use of marble [should be] disregarded…so that the beautiful, the rich, the grand and the precious . . . should stand out."[102] This continued into the next century, as evidenced by Sforza Pallavicino's work in support of Jesuit wealth, *Vindicationes Societatis Iesu*, written in the 1640s at the request of Father General Vincenzo Caraffa. In it, Pallavicino defends the wealth of the Society as a manifestation of loyalty from patrons in the Holy Roman Empire, France, and Spain, and as a sign of favor and reward for the excellent reputation of work of the Society.[103]

Monumental arches and gilded ornamentation in churches and schools contributed to the visual currency, credibility and sense of stability in Reformation Europe. But the ornate style associated with the early modern Jesuits represented a departure from the precedent established by religious orders who built with a conscious awareness of the potential scandal associated with ecclesial ostentation amidst the post-Reformation climate. Another founder might have recoiled at the expense. Religious orders of a previous age circulated stories of their founders weeping over newly constructed convents or churches that surpassed the limits of religious poverty. The Dominican *Constitutions* from the first general chapter at Bologna (1220) mandated that the order build "unpretentious houses" so as to not be "crushed by the expense and so that the secular clergy and other religious are not scandalized by the sumptuousness of our buildings."[104] The public witness of material poverty was a universal concern among existing orders, and the Franciscans, Augustinians, and newly formed orders recognized the importance of corporate as well as personal poverty. The Capuchins, for example, known as the "poor man's Jesuits," were a Catholic-

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[102] Quoted in Levy, "A Noble Medly and Concert of Materials and Artifice: Jesuit Church Interiors in Rome, 1567 – 1700," 58.

[103] Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century," 307.

[104] *Constitutiones antique ordinis fratrum predicatorum, Saint Dominic and His Times,* trans. H. Denifle, ed. M.H. Vicaire (Green Bay, WI: Alt Publishing Company, 1964), 77.

reformation religious community that lived a radical form of material poverty and grew rapidly, numbering about six thousand members by 1587.[105] Even with their phenomenal growth, the Capuchins were still outstripped by the Society, whose magnificent displays and triumphal architecture impacted European audiences and marked them as distinct from other orders.

New iconographic order

The Society's iconography differed dramatically from that of its contemporaries. Ignatius' choice of bold, elaborate architecture as an expression of the emerging Society's identity was a calculated risk and signaled the difference between this early modern foundation and orders of a previous age. The contrast is illustrated in two contemporaneous works of art that share the same motif: the central image of a religious founder who, having established his community, keeps watch over its inception and growth. The first example is a rendering of *St. Dominic and his Order* from 1675 (fig. 2) and the second is a depiction of St. Ignatius of Loyola, found on a frontispiece from Athanasias Kircher's 1646 *Horoscopium Catholicum Society Iesu* (fig. 3). The seventeenth century image of Dominic from a monastery at Estavayer le Lac, Switzerland[106] is a typical rendering of a medieval founder surrounded by his saints. Here Dominic, Adam-like, is asleep. From his side comes a multitude of animated Dominican heroes and heroines. The founder, however, is prone and passive, almost unaware of the vine that comes forth from his side to renew the medieval Church. The movement of the painting is both horizontal and vertical, crowned at the top by the Virgin Mary who bestows blessings and gifts on the Dominican Order from above.

[105] The Capuchins arose during the sixteenth century as an appeal to a more rigorous asceticism that more established orders lacked. They were joined in their ascetic practices by the newly established Theatines, Barnabites, Lazarists, Ursulines, and reformed Carmelites. See Hsia, *The World of Catholic Renewal,* 71.

[106] Figure 2 : « Arbre généalogique dominicain 1675, » http://dax.dominicaines.org/histoire/index.htm, Arbre généalogique dominicain 1675. Accessed 5 October 2017.

Figure 2: "The Genealogical Tree of St. Dominic" (1675) J. Rolbels, Monastery of Dominican Nuns, Estavayer-le-Lac.

The founder is empty handed, but the members of his family carry trophies that symbolize their earthly works and sacrifices. This heavenly cohort would have been born in a variety of cultures and circumstances, but there is no map to indicate these places nor is there a reference to the cities and villages where they lived and died. This depiction of Dominic and his chatty saints is warm and human; even the headless figure in the third row is being attended to by his accompanying brothers. Significantly, no one is attending to the silent founder who remains with them as they converse among themselves.

By contrast, the olive branch that springs from the side of Ignatius in this cover piece from Kircher's *Horologium Catholicum*[107] shows the founder wide awake, kneeling in prayer or perhaps in the middle of one of the *Exercises* (fig. 3). His legacy, like Dominic, is vast. But instead of

[107] Image: Kircher, Athanasius, and Gaspar Schott. *R. P. Athanasii Kircheri e. Societate Jesu iter exstaticum coeleste, quo mundi opificium, id est, cælestis expansi, siderumque tam errantium, quàm fixorum natura, vires, proprietates, singulorumque compositio et structura, ab infimo telluris globo, usque ad ultima mundi confinia, per ficti raptus integumentum explorata, novâ hypothesi exponitur ad veritatem, interlocutoribus Cosmiele et Theodidacto: hâc secundâ editione prælusionibus & scholiis illustratum; ac schematismis necessariis, qui deerant, exornatum; nec non à mendis, quæ in primam romanam editionem irrepserant, expurgatum, ipso auctore annuente*. Herbipoli: sumptibus Johannis Andreæ Endteri, & Wolfgangi junioris hæredum. Prostat Norimbergæ apud eosdem, 1671.

giving birth to conversing saints, this founder bears forth place names. Rome first, then Venice, Austria, Brazil, Japan, California – until no corner of the world (or the page) is left untouched by the Society. The many languages that emanate like rays from the four corners of the page and the cartographic detail immediately communicate movement, mission, order, and purpose. All of this activity is heavy with the watchful presence of the founder who remains alert and vigilant, even after death. Like the image of the sleeping Dominic and his flock, the eye is drawn upward, not to the benevolent gaze of the Mother of God but to a two headed eagle and a dove bearing an olive branch, suspended over the landscape.

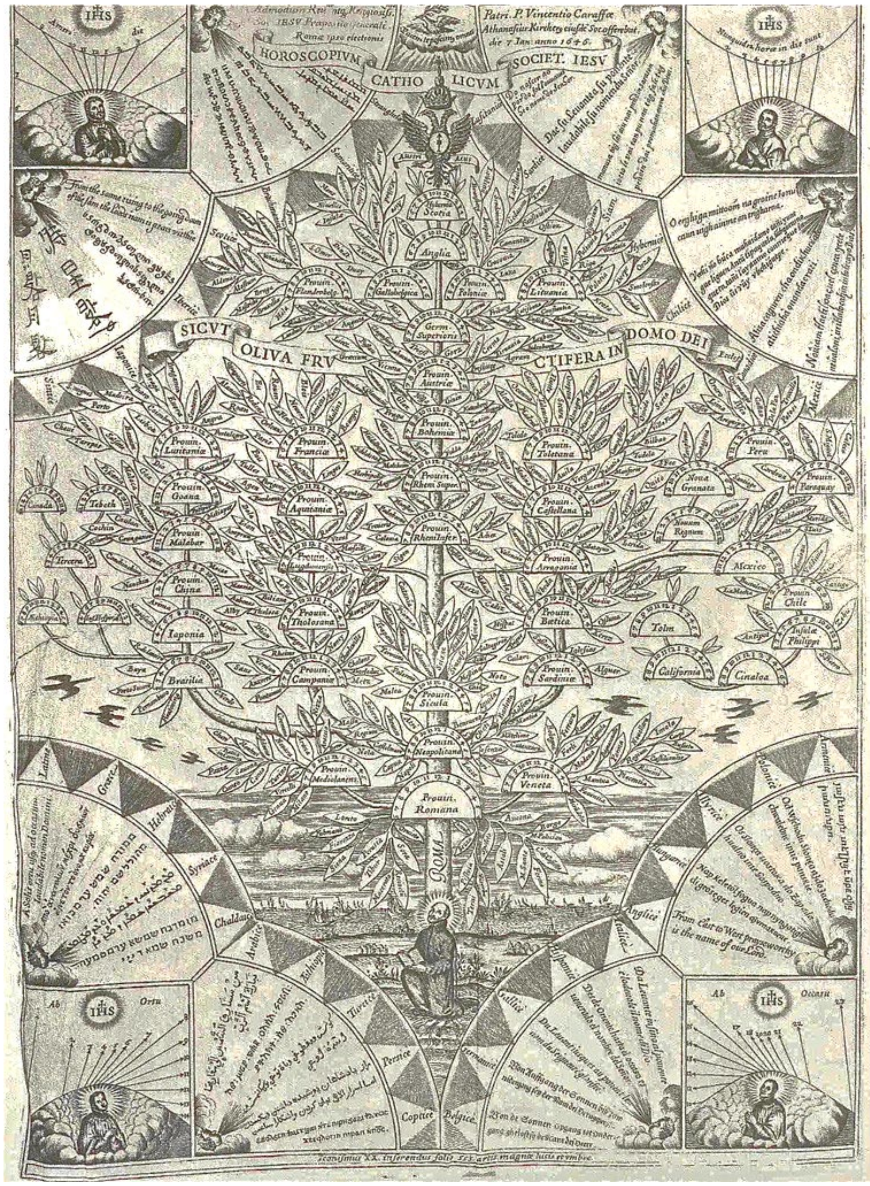
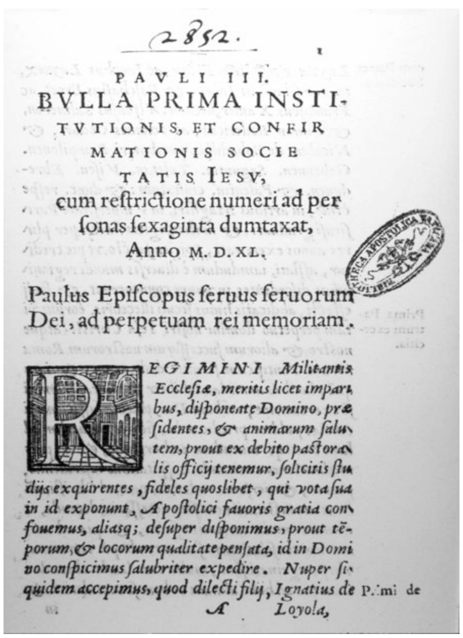


Figure 3: *Horoscopium Catholicum Societ. Iesu*, in: *A. Kircher, Ars Magna Lucis et Umbrae.* (Santiago de Compostela): Universidade de Santiago de Compostela, 2000.

The image of the Society is active and masculine, and although the first Jesuit confraternities that included women would have existed for nearly forty years at this 1646 production, they and the usually ubiquitous putti are in low relief.

To serve as a soldier of God

The individual members of the Society were tasked with confidently serving the order, whether they were sent on missions to large communities in established urban areas or alone on remote outposts. The confidence and zeal of the Jesuits was attenuated through a program of individual, rigorous formation, bold iconography and commitment to expansive missionary work. The Society bore a soldierly identity that was commensurate with the spirit of the age, and the Society's bull of promulgation, *Regimini Militantis Ecclesiae*, witnessed to their foundationally military character (fig. 4)[108]. Although they wore no distinctive external religious garb, the members of the Society were known for a demanding program of interior formation that lasted for an extended period of time and was particularly rigorous. Other religious founders such as Francis of Assisi took up arms in their youth out of zeal or compulsion for a king or a pope, but few founders incorporated the military motif of organization and identity into their orders in the way that Ignatius did.[109] Denis DeLucca's treatment of the Jesuits' influence upon military fortification theory in Europe further illustrates



2852.

PAVLI III.
BVLLA PRIMA INSTI-
TVTIONIS, ET CONFIR
MATIONIS SOCIE
TATIS IESV,
cum restrictione numeri ad per
sonas sexaginta dumtaxat,
Anno M. D. XL.

Paulus Episcopus seruus seruorum
Dei, ad perpetuam rei memoriam.

REGIMINI Militantis Ecclesiæ, meritis licet impari bus, disponente Domino, præsidentes, & animarum salutem, prout ex debito pastoralis officij tenemur, solicitis studijs exquirentes, fideles quoslibet, qui vota sua in id exponunt, Apostolici fauoris gratia confouemus, aliasq; desuper disponimus, prout temporum, & locorum qualitate pensata, id in Domino conspicimus salubriter expedire. Nuper siquidem accepimus, quod dilecti filij, Ignatius de Loyola,

Figure 4: Title page for *Regimini Militantis Ecclesiae.* Source: EBSCO History Reference Center. Boulder: Lakeside Publishing, n.d.

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108 From the *Regimini Militantis Ecclesiae* (1540), Introduction XXXV: "Whoever desires to serve as a Soldier of God beneath the banner of the Cross in our Society." See Antonio M. de Aldama, *Formula of the Institute, Notes for a Commentary,* trans. Ignacio Echaniz, (St. Louis: Institute of Jesuit Sources, 1990), 221.

Image: *Exercitia Militaria,* in *Vita S. Ignatii Lojola,* fig. 4, (Rome: Biblioteca Institutum Historicum Societatis Iesu, 1698), 16 B 28.

109 Medieval religious founder Francis of Assisi went on crusade and spent a year in captivity at Collestrada, but the spirituality of the Franciscans never assumed the motif of a military order.

how the Jesuits' military identity went beyond a mere metaphor.[110] Jesuit formation had no established time at which members were finally professed, but were granted full membership into the community after a period of testing, whose length was determined by their superiors. Some Jesuits like Christopher Clavius did not take vows until many years in the order. Clavius was finally professed at the age of thirty-seven, nearly twenty years after he joined the Society.[111] Steven Harris believes that the purpose of this formational testing was not so much to solidify the practice of obedience in the subject but to ensure their *reliability,* and to test whether the young Jesuit had thoroughly interiorized the Society's ideals and religious identity. Superiors watched to see if a young Jesuit could live the obedience *and* exercise personal initiative, knowing that he could be sent to remote parts of the world for extended periods of time without the immediate supervision of a superior. [112] A long period of probation, tested in experience made a reliable, trustworthy member. A reliable member ensured a trustworthy regiment, and legions of trustworthy members guaranteed, in theory, a universal Jesuit corps.

A rigorous missionary enterprise

Beyond a program of formation and bold iconography, the Jesuits soon became known throughout the world for their expansive presence in mission territories. Inspired by the exhortations of the *Spiritual Exercises* and fueled by the directives of Ignatius and his successors,

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[110] For further information on the Jesuits' use of mathematical faculties in support of military fortifications, publications and the Jesuits' controversial involvement in 'de re militari', See Denis Deluca*, Jesuits and Fortifications: The Contribution of the Jesuits to Military Architecture in the Baroque Age* (Leiden: Brill, 2012). Also, Dennis Smolarski, "Jesuits on the Moon" in *Studies in the Spirituality of Jesuits* (St. Louis, MO: Seminar on Jesuit Spirituality, 2005) Vol 37, 43.

[111] Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century," 288.

[112] Steven J. Harris, "Mapping Jesuit science: The Role of Travel in the Geography of Knowledge," in *The Jesuits: Cultures, Sciences, and the Arts, 1540 – 1773*, J. O'Malley, G. Bailey, S. Harris, T. Kennedy, eds. Toronto: University of Toronto Press, 1999, 230.

the members of the Society were trained as light infantry who were prepared to advance into new territory at any time. The movement of missionary Jesuits proceeded at times with unparalleled success in Europe, Asia, Africa, and the Americas as they were compelled by Ignatius to advance in a way that no continent would be left without a Jesuit presence. We read in a letter from Ignatius to Francis Xavier in 1552:

> The affairs of the Society, by God's goodness alone, are progressing and continually spreading in all parts of Christendom. God makes use of his frail instruments, He who, with or without them, is the author of all good.[113]

Jesuit missionary activity was marked by a unique collective identity that was defined in part by the fourth vow of obedience to the pope. This placed each member of the Society directly under the pope's service.[114] Centralized authority provided an antidote for the shifting and uncertain alliances in Catholic Europe and provided the pope with a reliable standing army that was ready to move at a moment's notice:

> The aim and end of this Society is, by traveling through the various regions of the world at the order of the supreme vicar of Christ our Lord or of the superior of the Society itself, to preach, hear confessions and use all the other means it can with the grace of God to help souls….[and] to admit young men who have because of their good habits of life and ability give hope that they will become both virtuous and learned in order to labor in the vineyard of Christ our Lord.[115]

Some scholars see the Jesuits' fourth vow of service to the pope as a mere extension of the vow of obedience, but it was more than that. Implicit in the fourth vow was the Jesuits' commitment to what Steven Harris calls anchored mobility, that bound the Jesuits to the service of the pope in

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[113] Saint Ignace au Père François Xavier, 31 janvier 1552, in *Lettres,* ed. Gervais Dumiege, S.J., (Paris: Desclée de Brouwer, 1958), Part IV, 263. «Les affaires de la Compagnie, grâce à seule bonté de Dieu, vont progressant et s'étendant continuellement dans toutes les régions de la chrétienté. Dieu se sert de ses faibles instruments, lui qui, avec ou sans eux, est l'auteur de tout bien.» [Trans. mine]

[114] J.J. Scarisbrick, *The Jesuits and the Catholic Reformation* (London: The Historical Association, 1993), 8.

[115] Loyola, *Constitutions, Part IV, Preamble, #308,* 173.

places beyond those secured by the Society. Long missionary posts with infrequent instruction and little supervision required the Jesuit missionary to uphold the vow of obedience, but also to employ creative initiative in challenging and unfamiliar circumstances.[116] Implicit in the fourth vow of obedience was a commitment to movement, a defining characteristic of the Society. Mendicant orders such as the Franciscans and Dominicans exercised the prerogative of itinerancy by exploring new territories and establishing new missions throughout the sixteenth century. Territorial expansion and conversion, a lingering effect of the Spanish *Reconquista,*[117] and commercial exploration of the fifteenth century prodded missionaries of the Catholic Reformation to extend their geographical reach even farther into new cultures and territories.[118] The immediacy of Jesuit travel at any given moment to any part of the world was inscribed in the 1550 *Constitutions* that read:

> Likewise, because the members of this Society ought to be ready at any hour to go to some or other parts of the world where they may be sent by the sovereign pontiff or their own superiors, they ought to be ready at a moment's notice."[119]

Traveling for the Jesuit was the norm rather than the exception. The *Preamble* to the *Constitutions* outlines the aim of the Society to "preach, hear confessions, and use all the other means it can with the grace of God to help souls," adding that this was accomplished by "traveling through the various regions of the world…."[120] The mendicancy of the Franciscans and Dominicans was grounded in a quasi-monastic manner of life that implied stability of place. If the mendicant friar

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[116] Harris, "Mapping Jesuit science: The Role of Travel in the Geography of Knowledge," 217.

[117] The *Reconquista* (from the 8th to the fifteenth century) was the period of Spanish reclamation after more than 700 years of Moslem domination.

[118] Andrew C. Ross, "Alessandro Valignano: The Jesuits and Culture in the East," in *The Jesuits: Cultures, Sciences, and the Arts, 1540 – 1773,* eds. J. O'Malley, G. Bailey, S. Harris, T. Kennedy (Toronto: University of Toronto Press, 1999), 338.

[119] Loyola, *Constitutions*, 217 ff.

[120] Ibid., 217.

left choir in the morning, he was expected to return there at day's end. The Jesuit, by contrast, was supposed to be *out*, not between the canonical recitation of hours but as an expression of his particular vocation.

Early Jesuits such as Francis Xavier and Matteo Ricci extended the limits of missionary commitment in a way not previously seen by actually exiting their own cultures and entering the host cultures that they served. They became completely integrated into the local customs, dress and practices of the peoples. Their sixteenth century contemporaries such as the Dominican Bartolomé de Las Casas lived and worked in missionary territories for extended periods of time, but none entered into native cultures to the degree that the early modern Jesuits did. Bernard-Maître observes that the decision of Francis Xavier to "exchange" his native cultural heritage for another was unprecedented and signaled a conscious transfer from Xavier's Iberian roots to the culture of the Japanese,[121] a move that later became a mark of Jesuit missionary strategy. Later in 1583, Michele Ruggeri donned the dress of the Buddhist clergy and saw this garb as "slightly different" from a soutane: "Now the robes are being cut and soon we will be made into Chinese."[122] For Ruggeri, wearing the cīvara of the Buddhist monks signaled entry into the host culture. This deviation from contemporary missionary practice incurred the risk of potential insult among native cultures but proved an effective strategy for Ruggeri and his evangelizing companions.

[121] Ross, "Alessandro Valignano: The Jesuits and Culture in the East," 342.

[122] Quoted in Matthew Liam Brockey, *Journey to the East, The Jesuit Mission to China, 1579 – 1724* (Cambridge, MA: Cambridge University Press, 2007), 33.

Circular letters and missionary correspondence

As the Society grew and dispersed beyond the borders of Europe, Ignatius met the challenges of growth and distance by instituting the practice of circular letters or "edifying reports," which provided regular communication between the provinces and Rome. As early as 1550, the *Constitutions* required members to write letters in the vernacular and Latin to the provincial and the Father General in Rome "that the news about the Society may be communicated to all."[123] These circular letters "which contain[ed] only the edifying reports"[124] were sent by local superiors to their provincials each week and to the Father General in Rome every month. Reports that were less than edifying were presumably excluded from circulation, as evidenced in an instruction from Ignatius in 1553:

> I recall telling you frequently face to face as well as writing you frequently when we were apart that any member of the Society intending to write us here ought to write out a main letter that can be shown to anybody; for there are many persons who are well disposed towards us and who want to see our letters, but to whom we dare not show them because they are disorganized and full of inappropriate matter. . . . Just recently I found it necessary, or at least quite useful, to show letters from two members of the Society to a couple of cardinals. . . but since the letters contained irrelevant, disorganized matter that was not suitable to be shown, I was hard put to it to let them see some parts and cover up the rest.[125]

Ignatius' contribution to the production of edifying letters was substantial: in the sixteen years of his generalship, he wrote over eight thousand letters.[126] Most of these letters, by his own account, were drafted multiple times before being made public, in order to maintain the standard of an edifying letter:

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[123] Ibid. 293.
[124] Ibid., 293.
[125] Ignatius of Loyola to Pierre Favre, Rome 10 December 1542," in *Letters and Instructions*, ed. John W. Padberg, et al., (St. Louis, Mo.: Institute of Jesuit Sources, 1996), 90–93.
[126] Hsia, *The World of Catholic Renewal,* 31.

> I will describe what I myself do and, I trust in the Lord, will continue doing in this regard so as to avoid mistakes when writing to members of the Society. I make a first draft of the main letter, reporting things that will be edifying; then, after reading it over and correcting it, keeping in mind that it is going to be read by everybody, I write or have someone write it out a second time. [127]

Jesuit correspondence was more than an informal exchange of news and events. It was a means by which the early Jesuits collected, edited, and disseminated pertinent information to specific audiences.[128] Letters were made public only after having passed through an editorial process.[129] In a moment of exasperation, Ignatius describes a self-imposed censorship on his own writing and exhorts the members of the Society to follow suit:

> For we must give even more thought to what we write than to what we say. Writing is permanent and gives lasting witness; we cannot mend or reinterpret it as easily as we can our speech. And even with all this I am sure I make many mistakes, and fear doing so in the future. I leave for the separate pages other details that are inappropriate for the main letter or lacking in edification. . . .it [the main letter] must be composed carefully and edifyingly, so that it can be shown around and give edification.
>
> Since I see everyone falling short on this score, I am sending everyone a copy of this letter, with a plea in our Lord that you always compose the main letter as I have indicated above, revise it, and then recopy it or have it recopied. If people will write two drafts like this, the way I do, I am sure the letters we get will be better thought through and organized.[130]

The Society made use of edifying letters to strengthen internal bonds among a community that was expanding geographically. The carefully crafted letters were also a way to promote the works of the Society, particularly with influential members of society.

The Society used this international network to communicate a variety of things, including natural discoveries, descriptions of native plants and animals, medicinals and curiosities.

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127 Loyola to Pierre Favre, *Letters and Instructions*, 90 – 93.
128 Harris, "Mapping Jesuit science," 232.
129 Ibid., 212.
130 Loyola to Pierre Favre, *Letters and Instructions*, 90 – 93.

Information about exotic places and things that were found in these territories was communicated to Rome which served to strengthen the Jesuits' notoriety and reputation in the Eternal City. A letter from Ignatius, written in Spanish in 1547 provides an insight:

> Some leading figures who in this city [Rome] read with much edification for themselves the letters from India, are wont to desire, and they request me repeatedly, that something should be written regarding the cosmography of those regions where Ours [i.e., Jesuits] live. They want to know, for instance, how long are the days of summer and of winter; when summer begins; whether the shadows move toward the left or toward the right. *Finally, if there are things that may seem extraordinary, let them be noted*, for instance, details about animals and plants that are either not known at all, or not of such a size, etc. *And this news – sauce for the taste of a certain curiosity that is not evil and is wont to be found among men* – may come in the same letters or in other letters separately.[131]

Why would a founder who formed his community that they might "strive especially for the defense and propagation of the faith and for the progress of souls in Christian life and doctrine,"[132] busy himself or his missionaries with information about seasonal solstices and native curiosities? In the *Spiritual Exercises*, Ignatius wrote that he desired that the members of the Society would "make ourselves indifferent to all created things . . . .,"[133] yet he knew that in order to remain at the center of European political and ecclesial life, the Society would have to employ other means to engage the attention of influential members of society. Patrons, prelates and politicians were,

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[131] Ignatius to Gaspar Barzaeo, 24 February 1554, *Monumenta Ignatiana. Epistolae et Instructions* (Madrid: Gabrielis Lopez del Horno, 1907), 358: "Algunas personas principales, que en esta ciudad leen con mucha edificación suya las letras de las Indias, suelen desear, y o piden diversas uezes, que se scriuiese algo de la cosmographia de las regiones donde andan los nuestros, come seria quán luengo[s] son los dies de verano y de yuierno, quando comença el verano, si las sombras uan sinistras, ó á la mano diestra. Finalmente, si otras cosas ay que parescan estraordinarias, se de auiso, como de animales y plantas no conocidas, ó no in tal grandeza, etc. Y esta salsa, para el gusto de alguna curiosidad que suele hauer en los hombres, no mala, puede uenir, ó en las mesmas letras, ó en otras de aparte." [Trans. mine.]

[132] Ignatius of Loyola, from the "Way of Proceeding" in *Formula of the Institute 1550*, ed. Antionio M. de Aldam, trans., Ignacio Echániz (St. Louis: Institute of Jesuit Sources, 1990), 3.

[133] Ignatius Loyola, *Spiritual Exercises*, trans., ed. Louis J. Puhl, S.J. (Westminster, MD: Newman Press, 1960), 9.

according to Ignatius, hungry for details about plants and animals from foreign lands, especially those "things that may seem extraordinary" to satisfy the curiosities of "leading figures" in Rome.

The missionary enterprise of the early modern Jesuits mirrors the unbridled global exploration and commercial trade that was exploding in Europe at this time. The ink was still drying on Mercator's map of America, and Tintoretto, Van Dyck, and Murillo were placing the finishing touches on their respective renditions of the *Flight into Egypt* when the Society began.[134] The Jesuits' eager participation in the wider movement of travel, discovery, and exchange enhanced their reputation as cosmopolitan, educated and culturally astute. Harris compares the Jesuit network of foreign missionary exchange to the commercial empire established by the East India Company in 1600.[135] Like the great London based trading company, mobility and an enterprising spirit of innovation was not only allowed but encouraged in the Society. Members used existing lines of communication and created new alliances to supply information about native cultures and natural resources that would satisfy the curiosities of patrons and draw attention to the Society from the unlikely quarters of scientific communities. The Jesuits' international network enabled the most current information to be supplied to its members and they in turn passed their newfound knowledge to patrons and students at their universities.

As the Jesuits began to realize the value of imported medicinals and natural curiosities from the missions to Rome, a continuous exchange of imported commodities flowed from members of the Society into Europe. But the importation of goods among missionaries comprised only part of the exchange; the more critical interchange among missionaries and missionary bases to the major

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[134] A fourth, by Cranach, precedes the Society by about 40 years. Bernard Grun, *The Timestables of History, 3rd ed.* (New York: Simon and Schuster, 1991), 272.

[135] Steven J. Harris, "Jesuit Scientific Activity in the Overseas Missions, 1540–1773," 72.

cities of Europe was the exchange of *knowledge*.[136] Circular letters and the founder's directive to forward information from the mission territories to Rome created a movement of natural knowledge within the Society. Jesuit missionaries collected, categorized and disseminated scientific information from remote outposts to Rome. This created a flow of knowledge from the periphery of the Society to its Roman core. No detail of native places or natural novelties was too insignificant for the edification and delight of Ignatius' audiences.[137] When the Society moved, *this* is what moved. No organization in or outside of the Catholic Church in the sixteenth century enjoyed the same access to rare, heterogeneous natural materials, and none had an equivalent capacity for extraction and exportation like the Society's enviably vast international network of communication. The Jesuit system of passing knowledge and experience across continents was the fastest and most reliable courier system in the world,[138] and this elaborate system of communication enabled the most current discoveries to be disseminated in a regular and systematic way. An established network of international correspondence allowed the Jesuits to import information into Rome and to provide members with access to new knowledge about geography, language, culture, and material goods. This gave the Jesuits a distinct advantage over their peers in the natural sciences.

Conclusion

From the beginning, the Society of Jesus was a surprise. Thirty-five years after their founding, the Society had become a massive enterprise: in 1574, the Society numbered 4,000 members in seventeen provinces. By 1608, their number grew to 10,640 members in thirty-one

[136] Harold Cook, *Matters of Exchange* (New Haven: Yale University Press, 2007), 1.

[137] For more on the establishment of global institutions in the early modern period: Steven Harris, "Jesuit Scientific Activity in the Overseas Missions, 1540–1773," *Isis* 96 (2005): 71-79.

[138] Steven J. Harris, "Jesuit Scientific Activity in the Overseas Missions, 1540–1773," 77.

provinces, with 306 colleges and sixty-five international missions. The Jesuits continued to open schools at an average of two to three *per annum* and managed to sustain this breathless momentum for more than two hundred years.[139] They were formed by a rigorous program of formation that prepared each priest for missionary work in a variety of cultural settings. The Jesuits' bold iconography, the strength of their numbers and their unparalleled commitment to missionary work made them recognized as a credible movement amidst the turmoil and strife of the Protestant and Catholic Reformations.

As the Jesuits invested themselves in strategies that would rekindle the credibility of the Catholic Church, a new opportunity arose when Christopher Clavius was summoned to serve on a papal committee tasked with rectifying the discrepancies of the Julian calendar. The misalignment of the Julian calendar with the placement of Easter had troubled popes for centuries. In post-Reformation Europe, it posed a challenge to ecclesial unity and was a source of embarrassment from internal and external audiences. After centuries of unsuccessful attempts, the solution to the discrepancy of the ecclesial calendar came not from a theologian or philosopher but from a priest-mathematician, Clavius of Bamberg.

[139] O'Malley, *The First Jesuits*, 207.

Image: Seal of the Society of Jesus ca. 1600, uncovered in 1990 during the restoration of the rooms of St. Ignatius, Rome. Saint, Site, and Sacred Strategy: Ignatius, Rome, and Jesuit Urbanism, T. Lucas, ed. Vatican City: Biblioteca Apostolic Vaticana, 1990.

Chapter Three
The Gregorian Reform of the Calendar: Not the work of Theologians or Philosophers, but Mathematicians

In astronomy our spirits are enraptured and lifted above the concerns of this terrestrial world, which never endures, to a world not subject to corruption at all.

– Clavius, *Sphaera* (1596)[140]

In the early 1580s, Christopher Clavius was appointed by Pope Gregory XIII to a papal committee that was tasked with the reform of the Julian calendar.[141] Calendrical discrepancies were a centuries old problem, but by 1514, the inaccuracies of the calendar regarding the correct day for the celebration of Easter drew detraction from several quarters. The onset of the Protestant Reformation exacerbated the need for a resolution. One solution, the Gregorian Calendar, was promulgated by the pope in 1582.[142] Clavius' participation in the calendar reform attracted attention from religious and scientific quarters. It was a watershed moment for Clavius and for the Society and a critical moment in Clavius' career as a mathematician. The success of the committee and his participation as a charter member allowed him to demonstrate that applied mathematics

[140] Christopher Clavius, In *Sphaeram Ioannis de Sacro Bosco Commentarius* (1596), trans. Eberhard Knobloch (Zürich: Olms-Weidmann, 1997), 313.

[141] C.V. Coyne, Michael A. Hoskin, Olaf Pedersen, *Gregorian reform of the calendar: proceedings of the Vatican Conference to commemorate its 400th anniversary, 1582-1982,* (Rome: Pontificia Academia Scientiarum, 1983), 47.

[142] Pope Gregory XIII *Inter Gravissimas* February 24, 1582, in Christoph Clavius, *Romani calendarii a Gregorio XIII, P.M. restituti explicatio* (Romae, A. Zannetti, 1603), 53.

could be used to solve important ecclesiastical and civil problems for a pope or king. The timing was critical, as Clavius' success in his work on the Gregorian calendar coincided with an emerging debate within the Society about the place of mathematics and the new sciences in the Society's program of pedagogical formation, the *Ratio Studiorum*. Clavius' achievement would provide a platform for him to advance his vision for mathematics within the Society. It would also bear influence upon the members of a committee commissioned to write the *Ratio* of the importance of mathematics and the new sciences in the Society's central curriculum and in the formation of its members.

This chapter introduces Christopher Clavius as a member of the Society of Jesus whose unique passion for mathematics and the new sciences produced the Society's first mathematics academy. The academy, founded as part of the Collegio Romano in Rome, would serve as a template for mathematics academies throughout Europe, Asia and the Americas. In addition, Clavius' mathematics academy in Rome would house mathematicians and scientists as part of a profession whose research, study and texts would be promulgated wherever the Jesuits served throughout the world.

Christoph Clavius Bamberggensis, Franciscus Villamoena 1606. Public Domain.

Clavius' emergence as a public figure in the sixteenth century through his participation in the Gregorian reform of the calendar afforded him quasi-celebrity status that allowed him to institute an academy of mathematics at the Collegio Romano, to attract and retain capable students for the academy and to draw influential patrons for his many projects. Clavius enjoyed a long tenure in Rome and spent his entire career teaching, writing and promoting mathematics and the new sciences at the academy. His extensive correspondence with mathematicians and scientists of the age testifies to the notoriety that he enjoyed among his peers in natural philosophy and the new sciences. Significantly in the post Reformation era, many of Clavius' lifelong correspondents transcended confessional lines. His regular interaction with royalty, influential patrons throughout Europe and loyal students scattered throughout the world attests to his capacity to reach a wide variety of audiences through mathematics and the mathematical sciences.

Clavius of Bamberg

Christopher Clavius is the only mathematician enshrined in St. Peter's Basilica. He appears on the tomb of Pope Gregory XIII, presenting the pope with a copy of the new calendar.[143] Clavius was born in Bamberg, Germany a few years before the Jesuits were founded. The exact year of his birth is uncertain but his birth date was March 25th, which was the first day of the year in many

[143] James Lattis, *Between Copernicus and Galileo: Christopher Clavius and the Collapse of Ptolemaic Cosmology* (Chicago: University of Chicago Press, 2010), 9.

regions of Europe in the 16th century.[144] Clavius was received into the Society at the hands of Ignatius of Loyola, and at the age of thirteen was sent to the Jesuit college in Coimbra in Portugal to begin his studies.[145] A pivotal moment for Clavius occurred here in 1560 when he witnessed a solar eclipse that he recorded lasted the length of a *Miserere*[146] or about two and a half minutes. Clavius was ordained after nine years but did not make a commitment of final vows until 1575 at the age of thirty-seven.[147] His official coursework at Coimbra reflected a standard program of traditional scholastic studies in philosophy and theology. After Coimbra, Clavius was sent to Rome to the Collegio Romano, now the Gregorian University, for further studies, where mathematics would have been presented as part of the quadrivium in the support of natural philosophy, mathematics and astronomy. In the absence of trained mathematicians or astronomers at Coimbra, Clavius educated himself in the principles of mathematics and the emerging sciences. A comment Clavius once made to his pupil Christopher Grienberger supports this:

> Christoph began to occupy himself with mathematics, that is what I heard from his mouth when he undertook the study of Aristotle's Posterior Analytics: the book was indeed so rich with mathematical examples, that he even without the aid of any master, dealt with it, so that in this profession, he claims to be, as the Greeks say, self-taught.[148]

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[144] Ibid., 12.
[145] Ibid., 15
[146] Ibid., 6.
[147] Martha Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century," in *Jesuit Science and the Republic of Letters,* ed. Mordechai Feingold (Cambridge, MA: MIT Press, 2003), 288.
[148] Quoted in Antonella Romano, *La Contre-Réforme Mathématique: Constitution et Diffusion d'une Culture Mathématique jésuite à La Renaissance (1540-1640)* (Rome: École Française de Rome, 1999), 91. "Christoph commença à s'occuper de mathématiques, c'est ce que j'entendis de sa bouche, alors qu'il entreprenait l'étude des Seconds analytiques d'Aristote : ce livre était en effet si riche d'exemples mathématiques, lui-même, sans l'aide d'aucun maître, de s'y attaquer, de sorte qu'en cette profession, il affirme être, comme disent les Grecs, autodidacte." [Trans. Mine]

Although Clavius had a proclivity for the new sciences, he would remain grounded in the texts of the Ancients for his entire career. After the discovery of a new star, sunspots, Jupiter's moons and the irregular surface of the moon, Clavius would walk a tightrope between observable phenomena and Ancient and Scholastic natural philosophy.

When Clavius arrived at the Collegio Romano, the first mathematics course was being taught by the Jesuit Baldassare de Torres. Clavius learned from de Torres and eventually adopted the program that de Torres began in 1553. Clavius would spend the next forty-five years at the Collegio Romano in Rome, teaching, adapting, promoting and defending mathematics and the natural sciences.

Clavius and the Gregorian reform of the calendar

Easter is a feast and not a planet.
-Johannes Kepler[149]

As a Jesuit mathematician and scientist and one of the early members of the Society, Clavius played a critical role in the development of the scientific culture in the Society of Jesus. His influence within the Society began with his participation in the mathematical recalculation of the Gregorian calendar. Upon its promulgation and implementation in 1582, new tensions emerged along Catholic and Protestant lines.[150] The reform or realignment of the calendar also

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[149] Quoted in H. M. Nobis, "The Reaction of Astronomers to the Gregorian Calendar," in *Gregorian Reform of the Calendar Proceedings of the Vatican Conference to Commemorate its 400th Anniversary,* G.V. Coyne, M.A. Hoskin and O. Pedersen, ed., (Vatican City, Vatican: Specola Vaticana, 1983), 250. "Ostern ist ein Fest vnd khein Stern" was written by Kepler in 1613 as a dialogue between a mathematician, a Catholic priest and a Protestant chancellor. The German text of this paper has only been published as the "Dialogus de Calendario Gregoriano."

[150] Benjamin J. Kaplan, *Divided by Faith: Religious Conflict and the Practice of Toleration in Early Modern Europe* (Harvard, MA: Harvard University Press, 2009, 86. In Augsburg, for example, the city council

resulted in an important first meeting between the Church and the mathematical sciences in the Early Modern era.

Clavius' participation in the committee that resolved the calendrical discrepancy to the satisfaction of Pope Gregory signaled a move from a semi-secluded life as a mathematics professor to a place of notoriety in the public square. Before October 1582, Clavius was generally unknown beyond the halls of the Collegio Romano. His work was limited to studies in preparation for the classroom. At the time, he had no published theoretical work and his contributions to mathematics were largely undocumented and unnoticed. His notebooks reveal little innovation and no new discoveries.[151] One of only two mathematicians on the committee,[152] Clavius did not enter the calendrical committee of Pope Gregory XIII, in the words of Ugo Baldini, "as the head of a brilliant crowd of mathematicians who only exist in the imagination of later historians,"[153] but as a little known consultant.

Pope Gregory XIII had instituted the committee to solve a centuries-old discrepancy that plagued the leaders of the Church. As early as the eighth century, Bede the Venerable (d.735) attempted to modify the calendar year in a way that would alleviate the drift of the calendar in relation to equinoxes. The second, parallel objective for the theologian and historian was to adjust the lunar year in relation to the celebration of Easter. Roger Bacon and other natural philosophers such as Pierre d'Ailly, Firmin of Belleval, John of Murs, Sacro Bosco, Nicolas of Cusa, Thomas

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voted to adopt the calendar to avoid economic disruption which incited a series of Protestant-Catholic revolts or "Kalenderstreit". Other territories of Germany suffered similar strife, along with areas of Switzerland, England.

[151] Ugo Baldini, "Christoph Clavius and the Scientific Scene in Rome," in *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary,* eds. G. Coyne, M. Hoskin and O. Pedersen (Vatican City, Vatican: Specola Vaticana, 1983), 142.

[152] Ibid., 147. Of those who signed the report presented to Pope Gregory XIII by the 1580 committee, only two were mathematicians, Christopher Clavius and Ignazio Danti. A third, the astronomer Antonio Lilio was standing in for his brother Luigi Lilio, who is credited with having framed the principles of reform before his death.

[153] Ibid., 143.

Campanella, and Regiomontanus also attempted to reconcile the calendar discrepancy.[154] Papal interest in solving the needed realignment of the calendar increased the urgency of the search for a viable solution. In 1516, the Fifth Lateran Council called upon Nicholas Copernicus (d. 1543) to pose a solution that would resolve the differences. Copernicus agreed to the commission but submitted an incomplete solution. Seventy years later, Copernicus' partial conclusions and his materials were used by Clavius and the committee to complete the project.[155]

The committee chosen by Pope Gregory to reform the ecclesial calendar was of an international composition. None were originally from Rome; participants came from Italy, Spain, France, and in the case of Clavius, Germany.[156] After the promulgation of the Gregorian Calendar, Clavius remained the only spokesperson, and for the next thirty years he defended the method and motives for the promulgation of the calendar, as Pope Gregory and the remaining members of the original committee died within a few years of the project's completion.[157] Clavius always credited Luigi Giglio as the principal framer of the calendar,[158] although the task of defending the work of the committee for the next three decades fell to Clavius.

Popish innovations

The Gregorian calendar was promulgated in 1582 by the papal bull, *Inter gravissimas* and was implemented on October 5 (which became October 15 to reset the calendar). The bull explains

154 J. D. North, "The Western Calendar, 'Intolerabilis, Horribilis, et Derisibilis': Four Centuries of Discontent," in *Gregorian Reform of the Calendar, Proceedings of the Vatican Conference to Commemorate its 400th Anniversary,* ed. G.V. Coyne, M.A. Hoskin and O. Pedersen (Vatican City: Specola Vaticana, 1983), 97.

155 Years after the promulgation of the Gregorian Calendar, Galileo would cite Copernicus' participation in the Church council as an endorsement (if indirect) by the Church that the theory of heliocentrism was in keeping with orthodoxy. See North, 97.

156 Ibid., 138.

157 August Ziggelaar, "The Papal Bull of 1582 Promulgating a Reform of the Calendar," in *Gregorian Reform of the Calendar*, G.V. Coyne, M.A. Hoskin, and O. Pedersen, eds. (Vatican City, Vatican: Specola Vaticana, 1983), 226.

158 Baldini, "Christoph Clavius and the Scientific Scene in Rome," 147.

the reasons for the delay in securing a satisfactory solution, including the priorities set forth by the Council of Trent and the "immense and almost inextricable difficulties which always accompany such a reform."[159] Following a lengthy explanation of the shifting of saints' feast days and the removal of ten days to reset the calendar, the bull ends with a proscription to all printers and publishers, followed by a grave warning:

> No one among men, therefore, is permitted to infringe on this page, our prescription, mandate, establishment, wish, approval, prohibition, suppression, abolition, exhortation and request, nor dare reckless opposition. But if you tamper with this, Almighty God will take you up with indignation, and you will be making an incursion against His happy apostles Peter and Paul."[160]

Dropping ten days from the calendar realigned the equinox to the time of the Council of Nicaea in 325. The Gregorian calendar at 365 and 97/400 days, or 365 days, 5 hours, 49 minutes and 12 seconds, had three fewer leap years for every 400 years than the Julian calendar. Copernicus' calculations set the year at 365 days, 14 hours, 33 minutes and 11 seconds.[161] The date of 4 October 1582 was the chosen day for the calendar implementation because of the minimal number of important feast days.[162]

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[159] Gregory XIII, Pope, *Inter Gravissimas* February 24, 1582, in Christoph Clavius, Romani calendarii a Gregorio XIII, P.M. restituti explicatio (Romae, A. Zannetti, 1603), 1, #4.

[160] *Nulli ergo omnino hominum liceat hanc paginam nostrorum præceptorum, mandatorum, statutorum, voluntatis, probationis, prohibitionis, sublationis, abolitionis, hortationis et rogationis infringere, vel ei ausu temerario contraire. Si quis autem hoc attentare præsumpserit, indignationem omnipotentis Dei ac beatorum Petri et Pauli apostolorum eius se noverit incursurum*. Gregory XIII, Pope, *Inter Gravissimas* February 24, 1582, in Christoph Clavius, Romani calendarii a Gregorio XIII, P.M. restituti explicatio (Romae, A. Zannetti, 1603), 3, #17.[Trans. M. Looney]

[161] Ibid.: 56.

[162] V. Frederick Rickey, "Mathematics of the Gregorian Calendar," *The Mathematical Intelligincer, Vol 7. No 1,* 1986: 54.

Reactions to the new calendar were varied.[163] The Protestant world resisted the reform[164] as many Protestants considered the Gregorian calendar to be an attempt by the papacy to drive another wedge into an already fractured Europe. The militant Protestant William Prynne called the calendar a "popish innovation,"[165] while others such as the German historian Ferdinand Kaltenbrunner criticized the pope's timing, believing that the reform should have been conducted earlier and presented at the Diet of Augsburg.[166] In some cases, the reform was seen as an encroachment on the new freedoms recently secured by the Protestant Reformation. A sermon penned by James Heerbrand, a professor of theology at Tübingen who referred to Pope Gregory as "Gregorius Calendarifex," prefaced his spirited comments in *Disputatio de adiaphoris et calendario Gregoriano* by stating that:

> We do not recognise this Lycurgus (or rather Draco, whose laws were said to be written in blood); we do not recognise this legislator, this calendar-maker, just as we do not hear the

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[163] Coyne, *Gregorian reform of the calendar,* 6. The final dates of incorporation, some as late as 1924, attest to the difficulty with which cultures and nations adapted. Some examples include: 1582 Italy, Spain, Portugal, Luxembourg, France, Belgium, German Catholic States, Catholic Netherlands, Poland 1583 Austria 1584 Catholic Switzerland 1587 Hungary 1600 Scotland 1700 Protestant Netherlands, Denmark, German Protestant States 1752 Britain and Empire (including American colonies), Quakers 1753 Sweden 1812 Rest of Switzerland 1867 Alaska 1873 Japan 1875 Egypt 1912 China, Albania 1917 Turkey 1918 Russia 1919 Yugoslavia, Romania 1923 Greece 1924 Eastern Orthodox Church in Romania, Yugoslavia, and Greece.

[164] Anne Lake Prescott, "Refusing Translation: The Gregorian Calendar and Early Modern English Writers," *The Yearbook of English Studies* 36 (2006), 2. Robert Pont, in "New Treatise of the Right Reckoning of the Yeares" (1599) relates doubts about Lilius's computational reckoning but adds that Christians should not "bee too much curious, concerning the observations of those Feastes", as the Scriptures caution us not to be "superstitious." Examples of more heated invective in England against the Gregorian Reform are many and well documented; John Donne's commentaries and poems on the subject are many. When England finally adopted the Gregorian Calendar in 1752, the results included a riot in Bristol that left several dead. A letter in The *Gentleman s Magazine* for September 1752 reads: "I desire some way of setting my affairs to rights, or, I believe I shall run mad. I went to bed last night, it was Wednesday, September 2, and the first thing I cast my eye upon this morning at the top of my paper was Thursday, September 14. Have I slept away eleven days in seven hours, or how is it? For my part, I don't find I'm more refreshed than after a common night's sleep. They tell me there's an act of Parliament for this.... But look at the difficulties it has caused! Our King, who was in Hanover, has been robbed of eleven days in his German dominions; some of our Saints have lost their days…." See also Hoskin, *Gregorian Reform of the Calendar,* 260.

[165] Hoskin, *Gregorian Reform of the Calendar,* 261. The Greek, Oriental, Coptic, Armenian, Nestorian, and Chaldean versions of the calendar were translated and dispatched with varying responses as well. For a treatment of the reception of the Gregorian Calendar in the Austria and the Lowlands see R.J. Gordon, "Controlling Time in the Habsburg Lands: The Introduction of the Gregorian Calendar in Austria below the Enns," *Austrian History Yearbook* 40 (2009): 28–36.

[166] Nobis, *Gregorian Reform of the Calendar:*250.

> shepherd of the flock of the Lord, but a howling wolf. All his loathsome and abominable errors, his sacriligious and idol-worshipping practices, his vicious, perverse and impious dogmas that are condemned by the word of God, the decrees vomited up from the letter casket of his belly, the torrent of evils, these little by little he will once more insert into our churches, he will newly plant his tyrannical yoke on our necks...…. Discharging the office of faithful shepherds, the slobbering wolf that threatens your flock you keep at a distance from the sheep pens and the flock, in your barking you are not guard dogs without a voice, you deny him and drive him away….Stand firm in that liberty of yours, and fight for it as befits strong athletes and soldiers of Christ.[167]

By contrast, some European Protestants such as the Goerlitz mathematician Bartholomaeus Sculetetus, Tycho Brahe, Johannes Kepler, and Paulus Guldin supported the reform.[168] Brahe began to use the new calendar almost immediately in his correspondence and data records, and remarked that the only problem with the calendar reform for the Protestant was that it was of Roman origin.[169] An inscription by Johannes Kepler thirty years after the calendar was released still accounted for the time difference: "This work was completed on the seventeenth or 27th day of May, 1618; but Book V was reread (while the typing was being set) on the 9th or 19th of February, 1619."[170] Kepler not only supported the reform but tried, unsuccessfully, to present the new calendar at the Diet of Regensburg in 1613 on astronomical and mathematical grounds.[171]

Clavius ultimately dedicated seven works in defense of the Gregorian calendar before his death in 1612.[172] For years, Clavius was attacked by Kepler's teacher, the Protestant astronomer Michael Maestlin, and the French humanist historian Joseph Scaliger said of Clavius: "He is a

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[167] Jakob Heerbrand and Curbinus, Martinus, trans., *Disputatio, De Adiaphoris, Et Calendario Gregoriano. Jacobus Heerbrandus.* (Tubingae: Hock, 1584), 110.

[168] Nobis, *Gregorian Reform of the Calendar:*244.

[169] Ibid., 250. For a complete treatment of the astronomical calculations of the Gregorian Calendar see J. Dobrzycki, "Astronomical Aspects of the Calendar Reform" in *Gregorian Reform of the Calendar*, G.V. Coyne, M.A. Hoskin and O. Pedersen, eds., (Vatican City, Vatican: Specola Vaticana, 1983): 121-133.

[170] Joannes Kepler, *Harmonies of the World,* ed., trans. S.W. Hawking, (Philadelphia: Running Press, 2002), 217. Also, in Nachum Dershowitz and Edward M. Reingold, *Calendrical Calculations* (Cambridge, MA: Cambridge University Press, 2008), xxv.

[171] Nobis, *Gregorian Reform of the Calendar:*250.

[172] Lattis, *Between Copernicus and Galileo,* 21.

German, of heavy and patient mind, and mathematicians must be like this. An outstandingly ingenious person cannot be a great mathematician."[173] Clavius also did not manage to escape John Donne's general dislike of Jesuits. In Donne's *Ignatius His Conclave* (1611), produced years after the controversial matter of the Gregorian calendar had settled, Donne criticized him "for the great paines also which hee tooke in the Gregorian Calendar, by which both the peace of the Church & Civill businesses have beene egregiously troubled," adding that not only earthly but even citizens of heaven were inconvenienced by the realignment of the calendar:

> Sts. Stephen, John Baptist, & all the rest, which have been commanded to worke miracles at certain appointed daies, where their Reliques are preserved, do not now attend till the day come, as they were accustomed, but are awaked ten daies sooner, and constrained by him to come downe from heaven to do that businesse.[174]

Although the onerous work of defending the calendar fell upon Clavius, he greatly benefitted from his participation on the committee. The 1580s were decisive years for the Society of Jesus[175] due in part to the Gregorian Reform of the calendar. Not only did the Jesuits establish their reputation as credible and unflinching transmitters of Catholic doctrine during these years but thanks to Clavius, received accolades from within the Church for solving an age old calendarial discrepancy. By extension, Clavius' participation in the calendar reform enabled the Society to be recognized for defending the honor of the pope and the Church at a decisive moment in Catholic Reformation history.

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[173] Christoph Clavius, *Corrispondenza,* Ed. Ugo Baldini, Pier Daniele Napolitani (Pisa: Universita Di Pisa 1992), V. 4,112. "Est Germanus, un esprit lourd & patient, & tales esse debent Mathematici; praeclarum ingenium non potest esse magnus Mathematicus." Trans. M. Looney.

[174] John Donne, *Ignatius His Conclave* (1611), ed. T.S. Healy, (Oxford: Clarendon Press; 1969), 17-19.

[175] Romano, *La Contre-Réforme Mathématique,* 111.

The solution to the ecclesial calendar was a mathematical achievement, but Clavius' contribution to the Gregorian reform was a primarily a *religious* event. In his 1603 *Explicatio*, written more than twenty years after the reform of the calendar, Clavius explained that although several solutions were feasible, ultimately the final design was the best the committee could have chosen, and that a better model had not surfaced in the ten years since its 1582 promulgation.[176] Clavius qualified this by describing the final design as scientifically complex, but ultimately the most faithful to religious tradition and particularly the Council of Nicaea.[177] Two years later in a letter to Antonio Possevino, Clavius wrote that,

> Indeed, the enthusiasm of that Mathematician should be praised whose opinion you have sent to me about the celebration of Easter, as well as his opinion that the decision should be completely rooted in the judgments of the ancient Pontiffs, the decrees of the sacred Council of Nicaea together with the long-standing customs of the Catholic Church.[178]

The approach of the reform of the calendar was rooted in the principle that best preserved the tradition of previous councils and maintained continuity within the celebration of holy days and feasts.

In response, Michael Maestlin accused Clavius of presumption in creating a new calendar. He retorted that the coming of the end times was eminent because of the presence of what he believed to be the antichrist pope, which made the reform of a calendar superfluous in Maestlin's estimation.[179] Clavius viewed Maestlin's attacks and similar detractions as religiously motivated.

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[176] Ziggelaar, "The Papal Bull of 1582 Promulgating a Reform of the Calendar," 205.

[177] Ibid., 230.

[178] Christoph Clavius to Antonio Possevino in Prahal, Roma, 13 April 1584, *Corrispondenza,* Part 1, Vol II-IV, 1570-1601, p. 51. Laudandus sane esset zelus Mathematici illius, cuius sententiam de celebratione paschae ad nos misisti nisi et Decreta antiquissimorum Pontificum, et Sanctiones Sacri concilii Nicaeni una cum vetustissima Ecclesiae Catholicae consuetudine funditus everteret. [Trans. M. Looney]

[179] Reinhold Bien. "Viète's Controversy with Clavius Over the Truly Gregorian Calendar." *Archive for History of Exact Sciences* 61, no. 1 (2007): 50.

Maestlin's criticisms, according to Clavius, were not a product of astronomical analysis but confessional bias in general and hatred of the pope in particular. In response, Clavius complained to the Catholic Emperor Rudolph II:

> Such is the perversity of some men – perhaps because of a defect in their nature or ill-informed zeal – that even false or absurd ideas seem to have their own promoters. Thus, what is good and praiseworthy often falls victim to all sorts of devious misrepresentations. For example, the Roman Calendar was recently approved and found free from errors by the authority of Gregory XIII the great *Pontifex Maximus*, by the rest of the Princes and scholars of the Catholic world, and by your sacred Majesty and has been circulated and well-received among all countries. *And although this has been done in a correct manner and is agreement with the custom and practice which the church of God has always used in celebrating the most holy day of Easter and other feasts which are called moveable, nevertheless there can be found a man such as Michael Maestlin of Tubingen. Infected by all kinds of false ideas, he has tried by heinous deceit to destroy the peace of the Catholic Church by attacking this most venerable and well-proven Calendar. I will not enumerate the ways by which he has deceitfully attempted to undermine the authority of the Roman Pontiff and the Church*.[180]

Clavius' participation on the committee, his mathematical and astronomical calculations and the years he spent defending the Gregorian calendar were *religious* acts in defense of the Church. In another letter to the Rudolph II, Clavius praised the emperor for remaining steadfast amidst many

[180] Christoph Clavius to Emperor Rudolf II, Roma, 18 ottobre 1588, *Corrispondenza,* Vol. II-IV, 1570-1601, 129. Tanta est nonnullorum hominum sive naturae vitio, seu pravo ipsorum studio perversitas CAESAR INVICTISSIME, ut quemadmodum nihiI unquam tam falsum absurdumque fuit, quod non suos patronos habuerit; ita nihil adeo verum, ac audabile, quod vituperatorum calumnias omnes effugerit. Argumento esse potest (ne longius abeam Calendarium Romanum nuper ex auctoritate GREGORI! Xlll Pont. Max. ingentique cum caeterorum Principum, gymnasiorumque orbis Catholici, tum vero sacrae Maiestatis tuae approbatione. ab erroribus, quos dies paulatim attulerat, vindicatum: et aliquando maximis omnium prope nationum studiis vel editum, vel receptum. Quod quidem tametsi et recte atque ordine factum est, et concinnatum apposite ad morem, usumque eum, quem semper DEI Ecclesia tenuit in celebrando sacrosancto Paschae die, caeterisque festis, quae mobilia appellantur; inventus est tamen Michael Maestlinus, Mathematicus, Tubingensis, qui ut est homo Ubiquetariae haeresis labe infectus, ita egregium hoc spectatumque Calendarium oppugnando, Ecclesiae Catholicae concordiam dissolvere nefaria fraude tentaret. Atque ut omittam ea, quibus Pontificis Romani, Ecclesiaeque auctoritatem contumeliose labefactare contendit: (ut facile coniicere liceat, eum neque veritatis, neque publici commode studio, sed odio Romani Pontificis novam anni restitutionem oppugnare). [Trans. M. Looney] [Italics mine]

detractors who, according to Clavius, were motivated by hatred of the pontiff and the desire to destroy the new calendar:

> It would be more appropriate to prove that he has fought against the new configuration of the year not by properly conducted analysis, but by hatred of the Roman Pontiff, and that hatred is the main weapon with which he has tried to destroy the new Calendar. Many reasons – not trivial or obscure—impel me to declare that you have a very powerful argument, O most invincible Caesar.[181]

The Emperor responded to Clavius by encouraging him to "continue refining and expanding the work in which you are so successfully engaged" for "the good of the State":

> Honorable, learned, diligent and beloved friend: We have received with grateful hand the book—an Argument for Calendar Reform—which you have produced and dedicated to us. It was especially welcome, since, being written with skill and genius, it gives evidence of such expertise that it effectively and cleverly disproves all contrary opinions. We believe that this book will be of primary importance in the midst of so many diverse and varied opinions now circulating about Calendar Reform. We bestow on you our highest praise and urge you, for the good of the State, to continue refining and expanding the work in which you are so successfully engaged. We honor you with our highest approval and at all times indulgently extend our imperial favor, by our patronage and authority.[182]

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[181] Christoph Clavius to Emperor Rudolph II, Roma 18 ottobre 1588, *Correspondenza*, Vol. II-IV, 1570-1601, eds. Ugo Baldini and Pier Napolitani (Pisa: University of Pisa, 1992), 130. Esset melius probare se adversus novam figuram annus non rite nihi sed odio Romanum Pontificem et odium maximum telum quod expugnabam novum calendarium. Multae rationes - levitate, vel maioris iturum, obscurum admodum potens ratio est quorundam opinio dicentium quod habetis, o maxime Caesar, invincibili. [Trans. M. Looney]

[182] Rudolph II to Christoph Clavius, Rome 3 ottobre 1592, Archivio della Pontificia Università Gregoriana, 530 cc. 75. Honorabilis, docte, devote dilecte. Quem nobis dedicasti librum Apologeticum pro reformato Calendario abs te editum, benigna manu accepimus qui cum magno ingenio et arte, quod artis periti nobis testantur, scriptus sit, contrariasque opmlones diligenter et docte refufet, nobis sane quam gratus fuit. Quem et publica inter tot tamque diversas diversorum de reformatione Calendari i sententias in primis utilem fare confidimus. Ut vero ita deinceps ista excolere atque illustrare studia, in qui bus adeo feliciter versaris, Republicae bono pergas, te pro singulari benignae voluntatis nostrae inclinatione qua te complectimur, etiam atque etiam hortamur, tibique gratiam nostram Caesaream, ad 20v quascumque occasiones ubi vel patrocinio vel auetoritate nostra opus sit, clementer offerimus. Datum in Arce nostra Regia Pragae, die tertia mensis Oetobris. Anno Domini Millesimo, Quingentesimo, Nonagesimo secundo. Regnorum nostrorum Romani decimo septimo, Hungarici vigesimo primo, Bohemici vero decimo octavo. Scribit. [Trans. M. Looney]

For Clavius, receiving papal support along with recognition from the Catholic princes of Europe was evidence that the reform of the calendar was legitimate. His defense of the calendar received praise from the Emperor who bestowed upon Clavius the "highest approval and…imperial favor," and encouraged Clavius to continue his work "for the good of the State." Clavius' work as a priest-mathematician supported the authority of the pope and by the Emperor's estimation, the welfare of the state.

The promulgation and defense of the Gregorian calendar came at a critical juncture for Clavius and the Society of Jesus and demonstrated that mathematical sciences could be used to bolster the authority of a pope, reinforce the Church's credibility and provide leverage against enemies when under attack. The Society was careful to defend its involvement with the calendar reform, evidenced by Clavius' editor, Johann Reinhard Ziegler, who wrote more than twenty-five years after the event that the objections of Georg Germann, an opponent of Clavius, were worth answering both for the Society's good name and the reputation of the calendar.[183] Clavius' participation in the Gregorian reform of the calendar was a stepping stone for his promotion of mathematics as a useful and necessary tool that could serve both sacred and secular ends. The reputation he acquired as a result of the calendar reform helped to ensure a place for mathematics within the pedagogical program of the Society as the *Ratio Studiorum* was drafted, and unprecedented growth in the Society ensured that hundreds of priests would be prepared for missionary work throughout the globe.

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[183] Joseph Juste Scaliger, *Scaligerana,* Editio altera. (Gravenhage: Coloniae Agrippinae, 1667), 51.

Clavius and mathematics: A balance of innovation and orthodoxy

Clavius was a naturally skilled diplomat who enjoyed cordial relationships with astronomers and mathematicians across confessional lines. He exercised a prerogative of silence in matters of controversy and avoided official censure throughout his career that gave him the necessary latitude to promote his program of mathematics in the Society. Bernadino Baldi, a contemporary biographer of Clavius said that, “He is a man untiring in his studies [. . .] He has an agreeable face with a masculine blush, and his hair is mixed in black and white. He speaks Italian very well, speaks Latin elegantly, and understands Greek. But as important as all these things, his disposition is such that he is pleasant with all those who converse with him.”[184]

Galileo and Clavius were friends for twenty years and Galileo referred to Clavius’ academy as “*gli accademici del padre Clavio.”*[185] Clavius’ influence on Galileo is well documented[186] and William Wallace’s meticulous translation of Galileo’s early notebooks that were omitted from Antonio Favaro’s twenty volume *Opere di Galileo Galilei*, provides strong evidence to support his thesis that Galileo’s early notebooks at the University of Pisa originated with Clavius’ 1589 edition of Euclid’s *Elements, Posterior Analytics* of Aristotle, Sacrobasco’s *Sphaera*, natural philosophy

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[184] Guido Zaccagnini, *Bernadino Baldi nella Vita e Nella Opere* (Pistoia: Society Anthology Tipo-Litografica Toscana, 1908), 344. Di statura è egli proporzionata, di membra robuste, di faccia grata che virilmente rosseggia, di pelo che ha del negro mescolato di canuto. Parla molto bene italiano, elegantissimamente latino et intende la lingua greca, e, quel lo che importa quasi più che tutte l'altre cose, è di costumi cos'i buoni et affabilmente gravi, che sodisfa coloro che si danno alla sua conversazione. [Trans. Sr M. A. Neenan]

[185] Quoted in Baldini, 144. “The academy of Father Clavius”

[186] Lattis, *Between Copernicus and Galileo,* 113. Adriano Carugo, Alistair Crombie, William Wallace have written of Clavius' influence on Galileo in philosophy and method. Peter Dear, William Donahue, Nicholas Jardine treat Clavius as a source of Early Modern education and cosmological theories. Ed Grant uses Clavius in sourcing the scholastic argument for the centrality and immobility of earth. Roman Gatto calls Clavius “undoubtedly one of the most important mathematicians of his time.” See Gatto, 235.

and planetary theory,[187] and class notes from Clavius' lectures. Wallace also traces Galileo's early thought through the unpublished lecture notebooks of Antonio Menu, Paolo Valla, Mazio Vitelleschi and Ludovic Ruggiero. [188] Evidence suggests that students of Clavius, Jesuit Jacopo Zabarella[189] and Domingo de Soto at the Collegio Romano discovered *uniformitas difformis* fifty years before Galileo. De Soto is mentioned by Galileo twice in an early work, *Tractatus de elementis* (1589-91), published by Galileo at the University of Pisa.[190]

In his first letter to Clavius (1588), Galileo asked Clavius about his demonstration of a problem on the center of gravity[191] prefacing with, "I prefer Your Reverend Lordship's judgment above that of any other. If you are silent, I shall be silent, too; if not, I shall turn to another demonstration."[192] In a second letter sent a month later, after having revealed his thought to Clavius, Galileo remarked that "I know that with friends of truth like Your Reverend Lordship one may and ought to speak freely."[193] But when Galileo asked Clavius for a response to whether or not his confirmed observations of Copernican theory could be officially taught, Clavius referred him to the Jesuit Robert Bellarmine for an answer.[194] In 1605, Clavius sent a copy of his *Geometria Practica* to Galileo and asks in return for his data on *Stella Nova Serpentarii*.[195] Two

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[187] William A. Wallace, Galileo and His Sources: The Heritage of the Collegio Romano in Galileo's Science (Princeton: Princeton University Press, 1984), 282; also: Annibale Fantoli, *Galileo, for Copernicanism and for the Church* (Cambridge: International Society for Science and Religion, 2007), 52.

[188] Lattis, *Between Copernicus and Galileo,* 5. See also: William Wallace, *Galileo and His Sources* (Princeton, NJ: Princeton University Press, 2014).

[189] William Wallace, "Randall Redivivus: Galileo and the Paduan Aristotelians," Journal of the History of Ideas, vol. 49 1988: 135.

[190] Alexander Koyre. "The Enigma of Domingo de Soto" in ren Taton, ed., History of Science Vol. II: The beginning of Modern Science, 1450-1800. A. J. Pomeranz, trans, (NY: Basic Books, 1964), 94-95.

[191] William Wallace, *Galileo and His Sources*, 223. Galileo submitted his calculation of the center of gravity of a plane parabolic section in conjunction with his application for a position at the University of Bologna in 1587.

[192] Galileo to Clavius, Rome, 25 Feb 1588, *Correspondenza* Vol. II, 1570-1592, 118.

[193] Ibid., 119.

[194] Romano, *La Contre-Réforme Mathématique,* 111.

[195] Fantoli, *Galileo for Copernicanism,* 71.

years before his death Clavius observed the moons of Jupiter and wrote to Galileo about the Medicean stars that, "Truly your Lordship deserves much praise since you are the first to have observed this…"[196] As a geocentrist, Clavius confirmed Galileo's observations of Saturn and Jupiter, and wrote in his 1611 version of *Sphæra* that, "since things are thus, astronomers ought to consider how the celestial orbs may be arranged in order to save these phenomena,"[197] but maintained neutrality with regard to drawing a conclusion based on his observations. To the end of Clavius' life, he remained neutral in his conclusions. On one occasion Galileo responded to Clavius' reticence by blaming the telescope and suggesting to Clavius that either his instrument was weak or he was using it improperly.[198]

Clavius managed to conserve the tradition of the Catholic Church while pursuing pure and mixed mathematics and the new sciences by a careful balance. In the vast correspondence amassed throughout his career, Clavius never assumed the task of assigning or reevaluating cosmology in relation to the Aristotelian tradition, nor did he seek to synthesize religious teaching with empirical scientific data. When the Tychonian Star of 1572 threatened the Aristotelian notion of static or immutable celestial spheres, the Jesuits embraced it under the heading of "saving the phenomena." Clavius was among the first to accept the new system.[199] More than twenty years later he wrote to Gabriel Seranno that he was waiting for Tycho's new hypothesis before he continued his work on the motions of the planets:

> It is reported that a noble Dane, Tycho Brahe has begun to work on the matter and has almost completed his fifth book, to observe again the heavenly motions with a new working

[196] Fantoli, *Galileo for Copernicanism,* 115.
[197] Quoted in Lattis, *Between Copernicus and Galileo,* 198, 261.
[198] Fantoli, *Galileo for Copernicanism,* 114.
[199] Edward Grant, "The Partial Transformation of Medieval Cosmology by Jesuits in the Sixteenth and Seventeenth Centuries," in *Jesuit Science and the Republic of Letters,* ed. Moredechai Feingold, (Cambridge, MA: MIT Press, 2003), 146.

> hypotheses. . . .I have decided to wait until the new hypothesis in the light in which he has examined them [before] I can make sure of some of the motions of the planets.[200]

As with Copernicus, Clavius acknowledged the validity of Tycho's data but refused to comment on the corruptibility or incorruptibility of the heavens.[201]

The 1570 edition of the *Commentarius* on Sacrobosco shows Clavius' proclivity for Ptolemy, with only passing references to Copernicus' data,[202] which would have been available for more than twenty-five years. Clavius presents the Copernican system as an alternative to the Ptolemaic system and briefly describes the system as one in which the Sun is immobile at the center and surrounded by the planets and Earth, along with a diagram of the Ptolemaic system. But the Copernican theory is left unillustrated with a brief refutation of the Copernican system.[203] In the same edition of 1570, Clavius promised a work on planetary theory, *Theoreticae planetarium* which would have explained theoretical astronomy in light of Copernican theory. Despite his extensive corpus, Clavius never got around to writing it. Christopher Grienberger, among others, regularly wrote Clavius asking when they could expect the publication to be completed.[204]

Clavius' silence on the topic speaks to the difficult position in which the Jesuits found themselves in the middle of the 16th century, particularly those engaged in the new sciences. In order to maintain the integrity of the Society's adherence to Aristotle and the Scholastics, Clavius' best option was to carefully consider, without adhering to contrary elements of cosmology, that

[200] Christoph Clavius a Gabriel Serrano in Salamanca Roma 21 luglio 1598, APUG 530 cc. 140r-140v, 145 [trans. M. Looney].

[201] Ed Grant, "The Partial Transformation of Medieval Cosmology", 146.

[202] Baldini, "The academy of Father Clavius," 150.

[203] Renée J. Raphael, "Copernicanism in the Classroom: Jesuit Natural Philosophy and Mathematics after 1633," *Journal for the History of Astronomy,* Vol. 46(4) (2015): 421.

[204] Baldini, "The academy of Father Clavius," 145.

which would potentially place him and his work at philosophical odds with his community. This gesture of placing mathematics and the new sciences in a subservient role to the faith was first seen in his defense of the Gregorian calendar, which was a scientific exercise that Clavius described as ultimately faithful to religious tradition and the Council of Nicaea.[205] Clavius the priest understood the limits of mathematical sciences. He made a conscious effort to preserve both the integrity of his religious tradition with the new realities that were gaining credibility in cosmology and the physical sciences. Clavius played a key role in the unfolding of mathematics and the new sciences but managed to remain suspended between orthodoxy and innovation throughout his long career. To the end he remained Aristotelian and Ptolemaic in his cosmology even though his career changing recalculation of the Julian calendar set him at odds with Ptolemy's calendric system.

Clavius exercised candor and honesty in his correspondence, freely admitting when he was in error, as seen in a note to a contemporary astronomer Kaczorononski, "I have been mistaken in dividing the horizon and have placed stars in their own parallel longitude – but now I realize this error."[206] After sustaining a vile and public refutation of the Gregorian calendar from François Viète, councilor to Kings Henry III and Henry IV of France, Clavius struck a conciliatory tone in the end and was willing to readily forgive him, despite the injustice of Viète's comments.[207] Clavius' collegial diplomacy extended until his death in 1612; he died on the eve of the Galilean trials and managed to avoid the great controversy altogether.

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[205] Ziggelaar, "The Papal Bull of 1582 Promulgating a Reform of the Calendar," 230.

[206] Salino to Clavius, Genova 19 April 1605, *Correspondenza* Vol. V-VII, 1602-1612, 155-156.

[207] Christopher Clavius, *Romani calendarii a Gregorio XIII P.M. restituti explicatio* (Rome: Aloysium Zanetti, 1603), introduction, xv.

James Lattis calls Clavius "the last important Ptolemaic astronomer" whose death signaled the end of a "fifteen hundred-year-old Ptolemaic tradition."[208] He spent his career at the Collegio Romano navigating the turbulent religious and epistemological waters of the sixteenth century, but wrote at the end that he enjoyed a long, happy life that was free, even in old age, from suffering. The dedication page in his last edition of *Opera mathematica* attests to his sanguine disposition:

> When it was seen by God Immortal…that he should will by a special benefit that I should live to such an advanced age [and that suffering] has not been my experience, indeed no part of my life has brought me more joy and accumulated pleasure than this decrepit old age…so far I have easily tolerated [suffering] so that I seem to have almost avoided all sense of sorrow.[209]

Conclusion

When Clavius was invited by Pope Gregory to serve on the committee tasked with the reformation of the calendar, he accomplished more than solving an administrative problem for the pope. He bolstered the credibility of the Church by using mathematics to conserve and uphold a religious tradition. Clavius' diplomatic skills and his ability to navigate a narrow path between orthodoxy and innovation made him an ideal spokesperson for the reform of the Gregorian

[208] Ibid., xiv.

[209] Christoph Clavius, Anton Hierat, Reinhard Eltz, and Johann Volmar, vol. 1, *Christophori Clavii Bambergsensis [...] Opera Mathematica V Tomis Distributa Ab Auctore Nunc Denuo Correcta Et Plurimis Locis Aucta* (Moguntiae: sumptibus Antonij Hierat, excudebat Reinhardus Eltz ..., 1611), 2. Quando ita Deo imoortali visum fuit . . . ut me singulari beneficio ad eam aetatem vivendo pervenire vellet, quam aut veterascentis mundi vitio, quod perinde ut rerum omnium, ita Naturae ipsius prima vis & efficacitas paulatim languescat: aut, qud ego magis crediderim, unius De arbitrio & dispenstione non admodum multos hac tempestate videmus attingere: hoc mihi longe gratissimum accidit, quod curm reiquis mortalibus ita fere contingat, ut dum hoc in procellolo mari nauigant, omnes vitae calamitates ac miseriae in extremam eius partem tanquam in sentinam quandam confluant, ego adeo contrarium experieear, ut nulla vitae meae pars maiore quam haec decrepita senectus gaudio & volptate cumulata extiterit. Non ego quidem praeter hominum morem & communem fortunam beatus, ab ijs unquam malis eximius & immunis fui, quibuscum tum reliqua vita, tum maxime exanguis haec & effoetaa quam dego aetas conflictari solet: sed quicquid id est quod communiter omnes patimur, ego iam ita facile tolero, ut omnem doloris sensum penitus amisisse videar. [Trans M. Looney]

calendar. In the Jesuits' efforts to secure credibility within the Church, Clavius' participation as a mathematician in support of religious orthodoxy was critical. Clavius' notoriety bolstered the reputation of the Society among Catholic, Protestant, and scientific audiences. Moreover, he demonstrated that mathematics was useful in the defense and support of the Church and the work of the Catholic Reformation.

After more than a millennium of searching for a resolution to the incongruities among the solar, lunar and sacred cycles, the spokesman for the solution was a relatively unknown priest-mathematician from the Collegio Romano. During the thirty years that followed the promulgation of the Gregorian calendar, Clavius' task of upholding the reform of the calendar amidst detraction ultimately brought notoriety to the Society. In defending the calendar, he ultimately defended the Church and demonstrated that mathematics had a unique capacity to solve practical problems, resolve conflicts and win the esteem of influential members of society. Pope Gregory's motivation for the calendar reform was for ecclesiastical reasons but the calendar discrepancies were solved by mathematicians.[210]

Despite the attention he garnered in the aftermath of the calendar reform, throughout his career Clavius avoided personal honours. When the citizens of Bamberg erected a statue in the town square in his honor, he declined to attend the dedication because he had much to do in the laboratory.[211] Many of his students became more renowned than their teacher. Among them were: Odo van Maelcote, Johann Adam von Bell, Matteo Ricci, Nicolas Trigault, Christopher Grienberger, Gaspar Alperio, Vincenzo Filliucci, and Angelo Giustiniani.[212] Students, mathematicians, experimental scientists, emperors and patrons from all parts of Europe, Asia and

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[210] Baldini, "The academy of Father Clavius," 236.
[211] Ibid., 22.
[212] Ibid., 24.

the Americas sought his advice, as is evidenced by the still extant volumes of his correspondence. Although Clavius rarely left Rome, his texts and circular letters traveled across continents and islands, were translated into multiple languages and used by countless students of mathematics.

The next chapter discusses how Clavius successfully established his mathematics academy at the Collegio Romano in Rome. As the academy grew, the flow of scientific and mathematical knowledge within the Society reversed its direction from the periphery to the Roman core. Scientific knowledge that was previously collected and disseminated from remote missions to the Roman center now, because of Clavius, emanated from the Roman core to the missions, shaping a new way for Jesuit missionaries to credibly engage secular audiences in their work as evangelizers.

Chapter Four
Men of the New Science:
Clavius' Academy at the Collegio Romano

From the Roman College, like a spring, there should emanate teachers, and schools and faculties for other places. Men should be fostered and trained here so that they can teach and share the good things the College has given them.

--Ignatius to Diego de Ledesma, first rector of the Collegio Romano[213]

Christopher Clavius' participation in the Gregorian reform of the calendar coincided with a critical moment in the Society of Jesus, when the definitive curriculum of the Society, the *Ratio Studiorum*, was beginning to take shape. Pope Gregory's bull which praised the work of the mathematicians on the committee was issued in 1582, four years before the first iteration of the *Ratio Studiorum*. Clavius capitalized upon the momentum gained by his participation in the papal committee and successfully introduced mathematics and the new sciences as independent disciplines that were worthy of consideration in themselves. In the forty-year process of defining and refining the seminal pedagogy of the Society, Clavius was able to introduce rigorous requirements for the study of mathematics and even added mandatory mathematics courses for students of theology and the humanities. As Clavius' mathematics academy gained momentum,

213 Quoted in Ladislaus Lukacs, S.J. and Giuseppe Cosentino, *Church, Culture and Curriculum; Theology and Mathematics in the Jesuit Ratio Studiorum,* trans. Frederick A. Homann, S.J., (Philadelphia: St. Joseph's University Press, 1999), 22.

however, a controversy surrounding the separation of mathematics from its traditional place in the quadrivium continued to flare, particularly among the natural philosophers in the Society.

This chapter presents Christopher Clavius as a visionary who founded an academy for the study of mathematics and the mathematical sciences, and spent his career recruiting students, securing benefactors and promoting the work of the academy. Among Clavius' uniquely noteworthy accomplishments was a calculated plan to form Catholic priests as mathematicians and scientists who would go forth as missionaries to secure credibility for the Society and the Church. During his nearly fifty years at the Collegio Romano, Clavius prepared mathematical missionaries, so to speak, to be part of a Catholic Reformation strategy of evangelization throughout Europe, Asia and the Americas. This included the selection of seminarians and students who would be formed, provided with the necessary texts and equipment and sent forth from Rome as ambassadors of the academy. Among their contemporaries and missionaries who came before them, the men of the academy were the most prepared and best trained missionaries in the Catholic Church and perhaps the world.

Mathematics at the Collegio Romano

The Collegio Romano (1551) was the Society's first college. It is the only college founded by Ignatius of Loyola, who oversaw the development of its curriculum and pedagogy.[214] The program of study in Jesuit schools emphasized the subjects needed for a seminary formation: philosophy, theology, and the study of letters – literature, history, rhetoric and languages, particularly Greek, Hebrew, and Oriental languages. Theological studies were mostly scholastic,

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214 Ricardo Garcia Villoslada, *Storia del Collegio Romano dal suo inizio (1551) alla soppressione della Compagnia di Gesu (1773)* (Rome: Gregorian Biblical Bookshop, 1954), 19.

favouring the works of St. Thomas Aquinas. The humanities formed the core of the pedagogy of the Society and the works of the Western canon maintained primacy of place until well after the death of Ignatius in 1556. The preface to the early *Constitutions* presents the formation in Letters as essential to learning and an indirect means of achieving the goal of attaining eternal life:

> Since the goal to which the Society rightly tends is to help attain the ultimate end of one's own soul and that of the neighbor's, for which they were created and since for this, in addition to the example of one's life, both learning and a way of explaining it are necessary…we must treat Letters and the way to use this knowledge.[215]

Prior to the final promulgation of the *Ratio Studiorum* in 1599, Jesuit pedagogy was comprised of a collection of traditional courses and formational elements that were added by Ignatius, including spiritual development, Christian piety and eloquence in Latin. Ignatius' direct involvement in the growth and development of the schools is evidenced in several ways, including seven chapters on the universities that he added to the *Constitutions* in 1553, three years before his death. At the time there were thirty-seven Jesuit colleges and universities scattered throughout Europe. Ignatius borrowed from the Universities of Paris, Cologne, Bologna, Padua and the Louvain to form an outline for the methods, mode of discipline, curricula, texts, administration, type of academic degrees, and the manner in which the religious life of students was expressed as part of the culture of the university.[216]

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215 Quoted in Lukacs and Cosentino, *Church, Culture and Curriculum,* 54.

216 Ibid., 22. Past the death of Ignatius, the Father General retained authority over every aspect of the Society's academic institutions. From the *Exposcit Debitum* (1550): "The general of the Society retains the full government or superintendency over the aforementioned colleges and students; and this pertains to the choice of rectors or governors and of the scholastics; the admission, dismissal, reception, and exclusion of the same; the enactment of statutes; the arrangement, instruction, edification, and correction of the scholastics; the manner of supplying them with food, clothing, and all other necessary materials; and every other kind of government, control, and care." See Aldama, Antonio de. *The Constitutions of the Society of Jesus: The Formula of the Institute, Notes for a Commentary*, trans. Ignacio Echániz. St. Louis: The Institute of Jesuit Sources, 1990, 22.

In a study on the development of the *Ratio Studiorum* and course content at the Collegio Romano, J.D. Moss notes an emphasis that was placed upon rhetoric in the early curriculum and final editions of the Society's pedagogical plan. Moss believes this to be an extension of the Jesuit's apologetic role as participants in the restoration of post-Reformation Catholic Church.[217] Following the traditional courses outlined in the trivium, students began courses in rhetoric around the age of seventeen. The course lasted several years, and students read multiple works including *Rhetorica ad Herennium, De inventione, De Oratore, Partitiones oratoriae* in the form of a disputation, and the orations of Cicero. Ludovico Carbone's *De dispositione oratoria* (1590) was used by the Jesuits as a formula for the development of rhetoric. Professors at the Collegio Romano presented traditional archetypes from antiquity and classical works to illustrate political or social ideals, a technique that was carried by Clavius throughout his works. The final 1599 edition of the *Ratio Studiorum* reflects a preference for humanities and rhetoric; Cicero is mentioned thirty-two times in the one-hundred- and eleven-page document, more than Aristotle and Aquinas. The *1599 Ratio* called for two hours of rhetoric in the morning and an additional two hours in the afternoon for the lower school. Rules for teachers of rhetoric fill seven pages, with an emphasis on the refinement of style and erudition. The selection of Cicero was a natural choice for the Jesuits, as the Roman orator combined speculative academics with a sense of civic duty. Cicero employed a pragmatic approach of proposing probabilities that would ultimately lead to the resolution of practical dilemmas.[218]

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[217] Jean Dietz Moss, "The Rhetoric Course at the Collegio Romano in the Latter Half of the Century," A Journal of the History of Rhetoric, Vol 4., No. 2 (Spring 1986), 138.

[218] In *De officiis* II, 7-8, Cicero explains the advantage of employing probability over certainty in reaching a conclusion: *There are those who say that some things are certain and others uncertain. I disagree with them: I would say that some things are probable and others improbable. Is there anything, then, to prevent me from pursuing what seems probable and rejecting the reverse? Surely by avoiding over-bold assertion one reduces the risk of being irrational, which is the very negation of philosophy. The very reason why we Academics question the certainty of everything is that the probability which I have mentioned could not come to light except from a*

Mathematics comprised part of the quadrivium and was included in the basic formal education of the collegiate. The early *Constitutions* reference mathematics as a complement to physics and a component of a liberal arts education.[219] In 1560, the Jesuit Father Geronimo Nadal (d. 1580), a member of the first generation of the companions of Ignatius of Loyola, a close collaborator and eventually the Vicar General of the Society, outlined the first program of mathematics for the Society's universities. Nadal's aim was to correct an apparent area of weakness in the application of the curriculum, and to ensure that "mathematics not be neglected."[220] Nadal's program called for a greater investment in the study of mathematics on the Society's part, which included special training for a core of mathematics teachers to explain problems which philosophy professors were unable to, "as it contributes to our goal."[221] In the same document Nadal added that, "We must teach logic, physics, metaphysics, moral science and *even* mathematics insofar as they suit our purpose."[222]

The reception of Nadal's proposal is not recorded, but within twenty years, Clavius convinced his superiors of the need for a three-year mathematics program. Throughout its history, the mathematics academy remained independent of the Collegio Romano, and self-sustaining. In 1580, Clavius implemented a course that was designed specifically for promising Jesuit

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comparative analysis of the arguments on both sides. See Robert A Maryks, *From Medieval Tutiorism to Modern Probabilism: "Spoils of Egypt" and the making of the Jesuit Conscience from Loyola to Pascal. Dissertation, Fordham University, New York. December 2005.,* 76.

219 Lukacs and Cosentino, *Church, Culture and Curriculum,* 55. In 1553, Ignatius referenced that the newly formed colleges should teach "the parts of mathematics that a theologian should know."

220 Geronimo Nadal "De artium liberalium studiis." *Monumenta Paedagogica Societati Iesu* (Rome: Institutum Historicum Societatis Iesu, 1965), 1565-1570, Vol. 2, 256. Mathematicae disciplinae praeteriri non debent .... vero privatis aut qui philosophiam profitetur magíster, si id facile possit; sin minus alius mathematicas explicabit, quatenus ad finem nobis propositum conveniunt. Sed spherae saltem cognitio habenda est; et cum nostri in academiis litteris dant operam, huic etiam disciplinae vacare studeant cum philosophiam audiant; aut si id fieri tunc non potuit, cum theologiae discipulus. [Translation M. Looney]

221 Ibid., Vol. 2, 256. [A]d finem nobis propositum conveniunt. [Translation mine]

222 Ibid., 257.

mathematicians. For the next fourteen years, the course remained in the catalogue and was registered as a fifth level or advanced course. The next year in 1595, the catalogue listed mathematics as an independent category.[223] Clavius' program of mathematics started with a small, select group of seminarians and priests, and gradually became an established part of the main curriculum of the Collegio Romano.

At the time of the Gregorian Reform there were only two chairs of mathematics in Rome, one at the Collegio Romano and the other at La Sapienza, founded in 1303. Throughout the sixteenth and seventeenth centuries, La Sapienza failed to produce anyone of note in the field of mathematics, and the quality of mathematics instruction at the college was variable. The list of professorial chairs at La Sapienza indicates that the program gave secondary status to mathematics, and course listings were placed outside the regular curriculum well into the seventeenth century. Lectures were poorly attended and there were only a few publications in pure or applied mathematics.[224]

By contrast, Clavius' rigorous mathematics program at the Collegio Romano was fueled by the vision and energy of its founder. The program was organized according to principles established in Greek mathematics and Aristotelian and Ptolemaic astronomy. Clavius reproduced the ancient texts that were supported by modern interpretation throughout his commentaries. He produced textbooks in practical algebra and arithmetic that formed the foundation of his program at the mathematics academy and ultimately the core mathematical knowledge of the Society.[225]

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[223] Rivka Feldhay, *Galileo and the Church: Political Inquisition or Critical Dialogue?* (Cambridge: Cambridge University Press, 1999), 110.

[224] Evidenced in manuscripts from the Biblioteca Nazionale. See Ugo Baldini, "Christoph Clavius and the Scientific Scene in Rome," in *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary,* eds. G. Coyne, M. Hoskin and O. Pedersen (Vatican City, Vatican: Specola Vaticana, 1983), 141.

[225] Feldhay, *Galileo and the Church,* 110.

The program remained relatively small and select but offered a variety of subjects for beginning and advanced students, including pure and mixed mathematics, geometry, algebra, statics, acoustics, astronomy, optics, the arts of demonstration, and syllogism.[226] Specialized programs were offered in both practical and interpretive mathematics.[227] From this small academy came generalists in mathematics and two types of specialists: pure mathematicians (Gregory of St. Vincent or Paul Guldin[228] for example); and mathematical astronomers and experimental scientists (Orazio Grassi and Giovanni Paolo Lembo).[229] Gregory of St. Vincent (d. 1667) would make significant contributions in the areas of refraction and reflection. He also wrote on comets, *Theses de cometis* (1619), and mechanics, *Theses mechanicae* (1620). At the Louvain, he developed methods that prepared for the development of integral and differential calculus. Paul Guldin (d. 1643), a Swiss mathematician and astronomer, is known for his close association with Johannes Kepler.[230] Orazio Grassi (d. 1564), who wrote under the pseudonym Sarsi when refuting Galileo on the nature of comets, wrote a tract on optics and the eye, *De iride disputatio optica* (1617) under another pseudonym, Galeazzo Mariscotto. [231]

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[226] Ugo Baldini, "The Academy of Mathematics of the Collegio Romano from 1553 to 1612," in *Jesuit Science and the Republic of Letters,* ed. Mordechai Feingold (Cambridge, MA: MIT Press, 2003), 52.

[227] Peter Dear, "The Church and the New Philosophy," in *Science, Culture and Popular Belief in Renaissance Europe*, eds. Stephen Pumfrey, Paolo Rossi and Maurice Slawinski (Manchester, NY: Manchester University Press, 1991), 134.

[228] Gregory of St. Vincent formed something similar in Antwerp to what Clavius was doing in Rome, except that his academy focused on pure mathematics. Gregory left behind 15,000 manuscript pages mostly on mathematics, including a theory of the tides and on the comet, which probably supports Tychonic cosmology. See G.H.W. Vanpaemel, "Jesuit Science in the Spanish Netherlands," in *Jesuit Science and the Republic of Letters,* ed. Mordechai Feingold (Cambridge, MA: MIT Press, 2003), 398. During his life, Gregory researched mathematical concepts we would now see as precursors to the infinitesimal calculus. See Dennis Smolarski, "Teaching Mathematics in the Seventeenth and Twenty-First Centuries," *Mathematics Magazine* 75 (Oct. 2002): 261.

[229] Baldini, *Jesuit Science and the Republic of Letters,* 58.

[230] Georg Schuppener, "Kepler's relation to the Jesuits – A Study of his correspondence with Paul Guldin." NTM Zeitschrift fur Geschichte der Wissenchaften, Technik und Medzin (December 1997), (1): 239.

[231] Pietro Redondi, *Galileo Heretic*, Princeton University Press, 1987, 196.

Clavius' mathematics academy stood in stark contrast to the apparent inertia of the mathematics department at La Sapienza, which would have been established for more than three hundred and fifty years at the time of the Collegio Romano's founding. Despite the notoriety of La Sapienza, its loyal ties of patronage and list of notable alumni, the University lacked the capacity to compete with Clavius' academy located less than two kilometres from the Collegio Romano. The success of Clavius' mathematical disciples indicate both the level of rigor in his program and his ability to attract talented mathematicians and scientists. He built the mathematics program from a few course offerings at the Collegio Romano into a robust, independent institution.

Another noteworthy aspect of Clavius' practical vision for the academy was its growth throughout the sixteenth and seventeenth centuries amidst growing competition from scientific societies that were being founded in Europe. Mordechai Feingold contrasts university-based programs of study in the mathematical sciences with the novel fascination of the new scientific societies in Early Modern Europe and describes scientific societies as hubs of innovative scientific experimentation that were cast as having the *illusion* of rigor. Because of this, scientific societies in Europe posed a threat to universities that were interested in attracting students who would commit to a dedicated and laborious study of science. Feingold suggests that the impact of scientific societies made it difficult for universities to attract and retain serious students of the sciences. In addition, new and established mathematics programs at the universities discovered that their patron base was drifting toward the more attractive option of scientific societies, which left university programs in even greater need of support for their material needs of their programs.

By contrast, Clavius' mathematics academy showed no signs of distress from the rising popularity of experimental scientific societies.[232] His competitive standards, rigorous curriculum, and the demands he placed on his students attracted steady enrollment from within the Society and among participants outside the community. Clavius' loyal patron network allowed him to fund multiple projects for decades, including textbook publication, academic scholarships, stipends for scholars, and a complete mathematics library at the Collegio Romano. Clavius managed to maintain high expectations, retain students and patrons, and remain untouched by the dangers that universities experienced as they developed programs of study in the mathematical sciences.

Admission to Clavius' program was highly selective. Clavius stipulated that admission to the program be restricted so that, "those especially be chosen who … are outstanding in talent, diligence, and in their liking for these [mathematical] sciences."[233] Only twenty-five students were allowed entry into the program. Once the candidates' aptitude for the work was determined, students were admitted by the nomination of a mathematics professor from a Jesuit college, or by consent of a Jesuit provincial superior. The special status of mathematics students at the academy allowed the select *mathematici* certain privileges, including an exemption from two of the advanced courses in philosophy and theology that were required by the *Constitutions* of the Society. They were also given lighter tutorial assignments than their peers.[234] The program of study included attendance at two lectures a day with an additional lecture on topics including the

[232] Mordechai Feingold, "Tradition Versus Modernity: Universities and Scientific Societies in the Early Modern Period." in Revolution and Continuity: Essays in the History and Philosophy of Modern Science Peter Barker and Roger Ariew, eds, (Washington DC: CUA Press, 1991): 55.

[233] Christopher Clavius, "De re mathematica instructio," in *Monumenta Paedagogica Societati Iesu* (Rome: Institutum Historicum Societatis Iesu, 1965), 117. Oporteret autem eos potissimum seligi, qui, reliquis paribus, ingenio, diligentia, atque in has scientias affectu ac docendi modo aliis omnibus praestent, non qui gratia alios supe rent, eiusque rei iudicium serio ab iis peti, qui eos in eo genere tractant. [Trans. D. Smoloski]

[234] Baldini, *Jesuit Science and the Republic of Letters,* 52.

theory of planets, sundials, and the astrolabe after the midday meal.[235] The corpus of reading for Clavius' mathematics program was ambitious: Giuseppe Cosentino estimates that the combined texts for mathematics students were between thirteen and fourteen hundred pages.[236]

Clavius' influence at the Collegio Romano enabled the establishment of distinguished scholar research positions called *scriptores*, which enabled scholars to be relieved from teaching responsibilities. These posts lasted from two to six years and were underwritten by patrons.[237] This innovative strategy gave scholars dedicated time to conduct research and engaged benefactors directly into work of the academy. Time dedicated for scholarship bore tremendous fruit and Jesuit contributions in mathematics and the sciences grew exponentially: between 1600 and 1773, Jesuit scholars produced nearly six thousand commentaries, translations, and original works in science and mathematics alone. The earlier works of scholars were Aristotelian in nature while later works in the new sciences included astronomy, mechanics, optics, astronomy, and applied mathematics.[238] In geography and natural history, the Jesuits produced over eight hundred titles before the Society was suppressed in 1773.[239]

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[235] Christopher Clavius, *De Re Mathematica Instructio* ed. Lukacs, Ladislaus, S.J., (Rome: Apud Monumenta Historica Soc. Iesu, 1965), vol. VII, 118. Quod satis commode uno anno fieri posset, si duas lectiones audirent singulis diebus; quod et fieri oporteret. Tum vero quadriennii illo theologiae spatio, sicut magistri futuri grammaticae, ubi vacatur a prandio, domesticis academiis exercentur, ita ipsi quoque a prandio per horam, eodem tempore, dum docendi finis fiat, theoricas planetarum, gnomonicen, astrolabium, aliquid ex Archimede et ex algebra, distributis quasi in orbem materiis, audire, atque ita instructiores ad docendum venire. Quod reliquis etiam studiis et omamento foret et utilitati. [Trans. M. Looney]

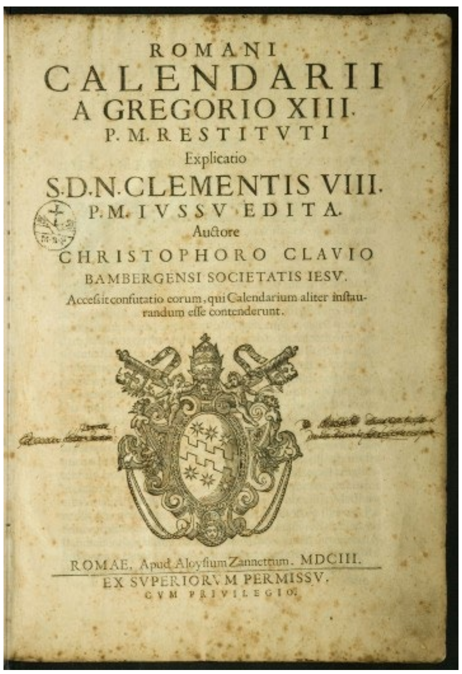
[236] Baldini, *Jesuit Science and the Republic of Letters,* 49.

[237] James M. Lattis, *Between Copernicus and Galileo: Christopher Clavius and the Collapse of the Ptolemaic Cosmology* (Chicago: University of Chicago Press, 2010), 24.

[238] Richard G. Olson, *Science and Religion 1450 – 1900: from Copernicus to Darwin* (Baltimore, MD: John Hopkins University Press, 2004), 69.

[239] Steven J. Harris, "Mapping Jesuit Science: The Role of Travel in the Geography of Knowledge," in *The Jesuits: Cultures, Sciences, and the Arts, 1540 – 1773,* eds. J. O'Malley, G. Bailey, S. Harris, T. Kennedy (Toronto: University of Toronto Press, 1999), 213.

By the early 1560s, Clavius' program of mathematics had already spread to prominent cities throughout Europe, including Vienna, Prague and Cologne. Later foundations followed in the early part of the seventeenth century in France.[240] The first chair of mathematics in France was established at Pona à Mousson, followed by Lyon, La Fleche, Tournon and Avignon.[241] Antonella Romano's scholarship on the French academies suggests that the mathematical texts that were used in the schools were brought by the Jesuit Fathers to France.[242]


ROMANI
CALENDARII
A GREGORIO XIII.
P. M. RESTITVTI
Explicatio
S.D.N.CLEMENTIS VIII.
P. M. IVSSV EDITA.
Auctore
CHRISTOPHORO CLAVIO
BAMBERGENSI SOCIETATIS IESV.
Accessit confutatio eorum, qui Calendarium aliter instaurandum esse contenderunt.
ROMAE, Apud Aloysium Zannettum. MDCIII.
EX SVPERIORVM PERMISSV.
CVM PRIVILEGIO.

Coverpage to Clavius' defense of the Gregorian Calendar (1603). Rare Book/Special Collections Library of Congress, Washington DC.

Clavius' mathematical texts were designed to provide a comprehensive formation beginning with baseline concepts and advancing to complex mathematics. Clavius' program allowed for adaptation according to the intellectual and cultural needs of the local mission. In Antwerp, a town populated with merchants, accountants and engineers, the Jesuits made a conscious move to implement a program of mathematics at the university that was designed to supply the practical needs of maritime industry and commerce.[243] When the Jesuits arrived from Portugal to Brazil in 1549, they realized that the teaching of mathematics would be confined to

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[240] Feldhay isolates four main relevant waves: 1. 1560s: Vienna, Prague, Cologne, Mainz; 2. 1580s / 90s: Dillngen, Graz, Ingolstadt, Louvain, Olomouc, Trier, Würzburg; 3. 1620s: Douai, Frieburg, Liege, Molscheim, Münster, Tyrnau; 4. 1660s ; See: Feldhay, *Galileo and the Church,*113.

[241] Feldhay, *Galileo and the Church,* 111.

[242] See: Antonella Romano, *La Contre-Réforme Mathématique, Constitution et Diffusion d'une Culture Mathématique Jésuite à La Renaissance (1540-1640)* (Rome: École Française de Rome, 1999), 77.

[243] Angelo de Bruycker, "'To the Adornment and Honour of the City': The Mathematics Course of the Flemish Jesuits in the Seventeenth Century," *BSHM Bulletin: Journal of the British Society for the History of Mathematics* 24 (2009): 139.

basic numbers, first operations with additional lectures in arithmetic for advanced students.[244] The establishment of schools in Brazil ran counter to their European strategy; the Jesuits first began schools for the native populations that were followed by schools for Europeans. Starting schools for native, less affluent students rather than beginning with wealthy students who could afford full tuition reflects the Jesuit imperative to make concrete adaptations to the needs of the local culture. Regardless of the circumstance, the motive of evangelization through mathematics remained the same; the application of mathematics changed according to the natural capacities and interests of the population.

Clavius' program insisted upon the application of rigor in the mathematical sciences but allowed for flexibility in adapting to the needs of a particular audience. The range of students that were taught by Jesuits using Clavius' curriculum and textbooks attests to the genius of his program in providing a mathematical corpus that would reach a wide range of students across cultures, languages and capacities. Clavius ensured that the mathematics academy at the Collegio Romano had a substantial library that was sufficient to support the mathematics program. The library was begun in the 1550s and at the time of Clavius' death was one of the largest collections of mathematical texts in Europe. It included works of classical and contemporary mathematics with handwritten dedications by Clavius and other authors, with books containing marginalia by faculty and students at the College.[245]

As previously mentioned, Clavius authored and edited numerous texts for the program. A listing in the 1566 course guidelines for the Collegio Romano included the first six books of *Euclid*, a book on arithmetic, a commentary on Sacrobosco's *Sphaera*, and texts on cosmography,

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[244] João Bosco Pitombeira Carvalho, "The history of mathematics education in Brazil." *The International Journal on Mathematics Education* [44](4): 500.

[245] Baldini, *Jesuit Science and the Republic of Letters,* 62.

astronomy, theory of planets, the Alphonsine Tables, optics and chronometry.[246] Clavius' commentary on Euclid's *Elements* was first published in 1574; because of it Clavius earned the title "the new Euclid"[247] even though several prior commentaries on Euclid were already in circulation by the late sixteenth century, as well as one published by John Dee.[248] Clavius republished his commentary on Euclid five times before his death in 1612, along with nine other original works, eight revisions of earlier editions of his texts and some minor tracts and publications of his collected works[249] including *Epitome arithmetica practica* (1583), a commentary on Theodosius' *Sphaerics* (1586),[250] *Astrolabium* (1593), *Geometria practica* (1604), *Algebra* (1608), and *Triangula sphaerica* (1611). The costs associated with the publication of texts were underwritten by patrons and the dedication pages demonstrate Clavius' conviction that the development of mathematics and the new sciences were critical as part of the Catholic Church's counter Reformation strategy. The next chapter provides examples of Clavius' dedication pages that provide detail about his conviction that a strong correlation between mathematics and the defense of the Catholic faith existed.

In addition to numerous texts and commentaries, Clavius is credited with several innovations including standardizing the use of the decimal point, introducing the square root, parentheses and the use of "x" for an unknown quantity.[251] He taught several generations of mathematicians and was a gifted teacher whose textbooks reveal his capacity to not only teach

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[246] Lattis, *Between Copernicus and Galileo,* 32.

[247] Romano Gatto, "Christoph Clavius' 'Ordo Servandus in Addiscendis Disciplinis Mathematicis' and the Teaching of Mathematics in Jesuit Colleges at the Beginning of the Modern Era," *Science & Education* 15 (2006): 235.

[248] J. D. North, "'The Western Calendar, 'Intolerabilis, Horribilis, et Derisibilis': Four Centuries of Discontent" in *Gregorian Reform of the Calendar,* eds. G.V. Coyne, M.A. Hoskin, and O. Pedersen (Vatican City, Vatican: Specola Vaticana, 1983), 102.

[249] Lattis, *Between Copernicus and Galileo,* 26.

[250] Baldini, *Jesuit Science and the Republic of Letters,* 144.

[251] Smolarski, "Teaching Mathematics in the Seventeenth and Twenty-First Centuries," 261.

students both novice and expert, but to teach his future teachers how to reach the full spectrum of students' capacities and interests. A work written in 1582 for a non-technical audience in conjunction with the papal bull *Inter gravissimas* reveals Clavius' talent for clear expository work.[252] He explained basic concepts using a variety of examples and in an informal tone (first or second person). He began with simple examples that led his learners toward gradual complexity. Clavius used humor, hyperbole and exaggeration to secure the attention of his students, examined problems from different perspectives and provided multiple examples to clarify difficult material for his pupils. Clavius enjoyed an easy rapport with his students, and his more advanced protégés such as Christopher Grienberger teased him about many things, including his love of Neapolitan pastries, as evidenced by the butter stains left on his lecture notes.[253]

Clavius' graduates were passionate about mathematics and they carried his teaching, methodologies and textbooks to the remotest ends of the world. His emphasis on repetition and logic in both pure and mixed mathematics, clear expository manner and dedicated mentorship of an international network of teachers and students,[254] made the program easy to replicate and export. Among numerous examples is an account from seventeenth century Korea, where Clavius' textbooks preceded the arrival of the Jesuits by decades. By the time the Hermit Kingdom opened

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[252] See: Christoph Clavius, *Romani calendarii a Gregorio XIII, P.M. restituti explicatio*, *S. D. N. Clementis VIII. P. M. Iussu edita: accesit confutatio eorum, qui Calendarium aliter instaurandum esse contenderunt* (Rome: Zannetti, 1603), 47.

[253] Ref: Christopher Grienberger to Clavius, Rome 23 March 1596, *Correspondenza,* eds. Ugo Baldini e Pier Daniele Napolitani (Pisa: Universita di Pisa, 1992), vol. III 1, 172. Cum hodie visitarem Nagium reperi ibidem tum P. Villalpandum tum P. Marium eum quem dum iret Neapolim T. R.a salutavit in lectica, qui legentes T. R.ae literas laetati sunt de bona valetudine, etenim vero sensimus nescio quam fragrantiam ex ipsis literis, bonique nescìo quid odoris sed sine gustu.[Trans. M. Looney]

[254] Feldhay, *Galileo and the Church,* 110.

its borders to Europe and the Jesuits were allowed passage, Koreans were already well versed in the European mathematical tradition.[255]

Public science

As the reputation of the academy grew, Clavius advocated for greater public recognition of the mathematics program. He proposed that the study of mathematical sciences and the accomplishments of students at the academy be made more visible at the Collegio Romano. This vision was reflected in the 1591 version the *Ratio Studiorum* that recommended students of mathematics be given an opportunity to display their knowledge once or twice a month by "demonstrating an illustrious mathematical problem" in the presence of the college's philosophers and professors.[256] The practice was adopted and copied throughout the Society's schools in Europe. At the College of La Fleche in France, an extended display of the students' mathematical knowledge was employed to celebrate the canonization of Sts. Ignatius and Francis Xavier. The day's program, described below, kept the audience rapt in attention for nearly ten hours:

> The mathematicians were still in the game and held the universe in their hands with the support of [Sts. Ignatius and Francis Xavier] ... Everyone was eager to hear a thousand beautiful things brought out by their arguments but there wasn't enough time to half satisfy the listeners who were in great number....On Thursday morning, the disputes in philosophy and mathematics continued…up to ten hours.[257]

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[255] Donald L. Baker "Jesuit Science through Korean Eyes," The Journal of Korean Studies, Vol. 4 (1982-83): 207.

[256] Christopher Clavius, "Regulae Professoris Mathematicae," in *Monumenta Paedagogica Societati Iesu* (Rome: Institutum Historicum Societatis Iesu, 1965), Vol. V, 402. Singulis aut alternis saltem mensibus ab aliquo auditorum magno philosophorum theologorumque conventu illustre problema mathematicum enodandum curet; posteaque, si videbitur, argumenta. [Trans. M. Looney]

[257] Quoted in Romano, 494. *Le triomphe des Saints:* « Les mathématiciens furent encore de la partie, mirent le globe de l'univers entre les mains des S.S. comme s'ils en étaient le support ; leur doctrine et leur Sainteté ayant empêche sa ruine…Chacun était désireux d'entendre mille belles curiosités, dont leurs thèses étaient composées, de sorte qu'il n'y eut pas le temps à demi pour rassasier l'affection des auditeurs, qui y furent en très grand nombre et fallut de nécessité quitter l'explication des problèmes, tous appliqués aux qualités vertus et perfections des Saints,

At La Fleche, the first canonizations of the Society were an ecclesial celebration, but also an opportunity for the grandeur of mathematics to be on display.

In Rome, the scope of celebratory events grew as students in the mathematics program at the Collegio Romano defended theses in the mathematical sciences amidst grandiose public displays that included catered meals and impromptu speeches scattered throughout the defense. Orchestras were hired to play motets that were composed for the occasion, and poetic works were penned and recited for the candidates by their favourite instructors.[258] Student presentation days were announced by elaborate thesis prints that were drawn up by the publishers Zannetti and Mascardi.[259] More notable guests received individualized silk prints to commemorate the event.[260] Louise Rice comments that eventually thesis prints became so elaborate that their decorative borders overtook the actual text for the program.[261] What began as a small, scholarly exercise evolved into a major social event for professors and students of mathematics and the sciences. Jesuit universities throughout the world followed precedent and added ceremonial flourishes to student defenses in areas outside of mathematics, including geography, horticulture, astronomy, cartography, optics, chronometry and magnetism.

At the Collegio Romano, teachers in mathematics were soon included at all formal academic occasions. Mathematics and the sciences were being recognized as their own discipline and were gaining credibility through the presence of mathematics students in disputation, theses

afin de donner place à ceux qui voulaient disputer. … Le jeudi matin, les disputes de philosophie et de mathématiques furent continuées avec les affiches jusqu'à dix heures.» [Trans. Mine]

[258] Louise Rice, "Jesuit Thesis Prints and the Festive Academic Defense," in *The Jesuits: Cultures, Sciences, and the Arts, 1540 – 1773,* eds. J. O'Malley, G. Bailey, S. Harris, T. Kennedy (Toronto: University of Toronto Press, 1999), 159.

[259] Gorman, "Mathematics and Modesty in the Society of Jesus," in *The New Science and Jesuit Science: Seventeenth Century Perspectives* (Dordrecht, The Netherlands: Kluwer Academic Publishers, 2003), 16.

[260] Rice, "Jesuit Thesis Prints and the Festive Academic Defense," 154.

[261] Ibid., 152.

defenses, plays and other university events. The efforts of Clavius to promote mathematics allowed it to emerge as a public affair. The elaborate ceremonies that drew mathematics and the new sciences into the public square were part of a strategy which, I argue in the next chapter, signaled a conscious move on the part of Clavius and his collaborators to attract attention to the academy and enhance the prestige of mathematics within the Society, as a work of evangelization.

Through these public gestures, Clavius successfully demonstrated the place of mathematics to the internal audience of his fellow Jesuits and the wider public beyond the Collegio Romano. He also reinforced the idea that the university was the social and educational locus for the study of serious, committed mathematics, rather than the scientific societies.[262] Clavius' vision for the new man of science whose vocation was dedicated solely to the advancement of mathematics and the new sciences was created in the context of the university.[263] At the same time, the level of sophistication and specialization in Clavius' mathematics program separated it from the general scholarly work of the university, and created a distinct category of method, study, and more importantly, knowing.

Most practitioners of mathematics and the new sciences were drawn to Clavius' academy from outside of Rome. They became skilled in mathematics and the experimental sciences as students of Clavius' academy. Through their preparatory studies at the Collegio Romano, they were armed with the necessary knowledge to refute whatever threatened to dismantle Catholic doctrine and teaching,[264] and graduates of Clavius' academy developed as an independent body, later becoming involved in policing the work of Galileo and others. These specialists grew in

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[262] David S. Lux, *Patronage and Royal Science in Seventeenth-Century France : The Academie De Physique in Caen* (Ithaca, NY: Cornell University Press, 2019), 39.

[263] Feingold, "Tradition Versus Modernity: Universities and Scientific Societies in the Early Modern Period," 54.

[264] Lattis, *Between Copernicus and Galileo,* 4.

number and became an important part of the academy's public face. As their contributions to the mathematical sciences increased, the Jesuits' notoriety in scientific and ecclesial circles increased proportionally.[265]

Conclusion

As the mathematical sciences continued to gain credibility within the Society's program of studies, the reputation of the academy spread beyond the Collegio Romano. Within ten years of Clavius' first attempt to impress upon his superiors the importance of including mathematics in the formational program for the Society, mathematics moved from a discipline in support of the sciences to its own independent study. Textbooks, commentaries, dedicated *scriptores*, an extensive library and a growing network of mathematics academies attest to the prestige of Clavius' academy and the influence his program was beginning to wield in the Society.

The inception and growth of Clavius' mathematics academy and his ability to leverage support for the place of mathematics in the formational curriculum of the Society did not happen by chance; it was a premeditated strategy with clear objectives. The next chapter details this strategy for the promotion of mathematics and the new sciences through the writings of Clavius, beginning around the time of the foundation of the academy and continuing until his death in 1612. These demonstrate a carefully conceived plan that advocated for the independent study of mathematics at the Collegio Romano and promoted the mathematical sciences as a means of evangelizing new cultures, drawing Catholics back to their faith and bolstering the credibility and prestige of the Society.

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[265] Lattis, *Between Copernicus and Galileo,* 17.

Chapter Five
Christopher Clavius' strategy for the promotion of mathematics

For Clavius, the study of mathematics and the new sciences served more than a preparatory function within the curriculum of the collegiate; it was a critical component of the Jesuits' comprehensive Catholic Reformation strategy. Clavius was confident that the usefulness of these disciplines would communicate the credibility and certainty of the Society and contribute to the Jesuit program of Catholic restoration. His conviction about the persuasive power of the mathematical sciences led Clavius to present the study of mathematics and the new sciences as a *missionary vocation,* that is, a call to preach the Catholic faith in a particular way, and to claim that those who were chosen and prepared for this vocation through study, teaching and research were the recipients of a unique call; the men of the academy were destined to serve the Society and the Church in a specialized way. This chapter discusses Clavius' correspondence, dedications to benefactors, polemical pamphlets, textbook prefaces and treatises submitted as part of the *Monumenta Paedagogiae* which outline his vision for the promotion and development of the mathematics academy at the Collegio Romano.

As mentioned in chapter two, between the years 1582 and 1599, a committee within the Society was convened to formulate a pedagogical plan for the Society that would eventually become the *Ratio Studiorum*. Clavius was included as a member of the committee, and his participation in these meetings allowed him to submit several works that were included in the final document. Among those that were received and incorporated into different versions of the *Ratio* were several treatises on the place of mathematical learning in the community. These included: *Ordo servandus in addiscendis disciplinis mathematicis* (1581), which provided a summary of the order of mathematics instruction; *Modus quo disciplinae mathematicae in scholis Sodetatis posent promoveri* (1582), a treatise on the ways in which teaching mathematics advances the Society; *De re mathematica instruction* (c. 1593), a document that discussed the teaching of mathematics; *Varia de rebus mathematicis discendis et tradendis* (1593), an instruction on the teaching of mathematics; and two discourses, *Oratio de modo promovendi in Societate studia linguarum. politiores litreras ac mathematicus etc. contra haereticorum argutiam* (1594); and *P. Christophori Clavii de modo et via qua Societas ad maiorem Dei honorem et animarum profectum augere hominum de se opinionem, omnemque haereticorum in literis aestimationem, qua illi multum nituntur, convellere brevissime et facillime possit* (1594); that treated the ways in which the teaching of mathematics enhanced the prestige and credibility of the Society, and strengthened it against the threats and accusations of heretics.

Most of Clavius' works were technical in nature. His textbooks and commentaries designed for classroom use introduce a concept, provide illustrations and examples, and resolve difficulties within the topic. Even texts that are didactic in nature contain exhortations that support his central thesis: that the study of mathematics and the new sciences is, in itself, useful and necessary. He constantly reinforced this to his audiences, whether a student, benefactor, prelate or a superior in the Society, believing that the useful, necessary qualities of mathematics made them essential for the preservation of civic society and support of the post-Reformation Church.

Clavius' vision

Within Clavius' corpus of writings, three different themes emerge that articulate his vision for the mathematical sciences. They form the outline of a theoretical and practical program for the promotion of mathematics and the new sciences. The first theme in Clavius' writings establishes the basic premise that mathematics is certain and worthy of study for its own sake. Clavius eloquently describes how mathematics and the mathematical sciences guide the mind towards the clear judgment of all things. Mathematics is logical, certain and useful to society; by its own merits it should be recognized in the pedagogy of the Society.

The second theme builds upon the foundational worthiness of the discipline of mathematics by stating that the certainty mathematics and the new sciences are not only worthy of study for their certainty and utility, they are also brilliant and edifying. They raise the mind and heart to the contemplation of celestial things and ultimately to God. Because of the purity of their content, mathematics and the new sciences are in themselves a way to attract youth. Furthermore, their nobility and certainty make them an influential and important component in winning hearts and minds to the truths of faith. This natural attraction, Clavius argues, will through their inherent beauty and reasonableness draw all eyes to the Catholic faith and to the Society. In addition to the magnetic attraction of mathematics and its usefulness in drawing others to the faith, Clavius is convinced that the certainty of mathematics can be used to confound heretics and enemies of the Church and of the Society.

After establishing that mathematics is useful in drawing others to the truths of faith by virtue of its inherent reasonableness, Clavius calls for the study of mathematics and the new sciences *as a chosen ministry* within the Society. In this third and final phase, Clavius moves from speculative observations about the utility, beauty and power of mathematics to practical assertions and a detailed program of action that includes the formation of future mathematical missionaries in the academy. Clavius maintains that the creation of a corps of Jesuit priests trained especially in mathematics and the new sciences would serve as powerful weapons against error, create stability in post-Reformation Europe and establish unique credibility based on its own merits. Once their training was complete, priests trained as mathematical missionaries would go forth and by the mathematical sciences, draw others to the truths of faith, bring credibility to the Society and secure confidence in the Catholic Church.

Mathematics as a source of certain knowledge

Clavius first presents the study of mathematics and the new sciences as inherently valuable, as disciplines which contain knowledge that is certain, credible and demonstrable. In his commentary on *Proclus*, Clavius states that by the certainty of their demonstration the mathematical disciplines are deserving of a rank in the hierarchy of the sciences. In the *Prolegomena* he writes, "Yet if the nobility and excellence of a science has to be judged by the certainty of the demonstrations it uses, undoubtedly the mathematical disciplines will hold the first place among all others."[266] In his rationale for an exalted rank for mathematics, Clavius uses an interesting phrase to build his case: he describes mathematical and scientific knowledge as a *noble doctrine*. Clavius' word choice in correlating the certainty of mathematical demonstration with the certainty of doctrinal knowledge suggests that for Clavius, the mathematical sciences clarify

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[266] Christopher Clavius, "In disciplinas mathematicas prolegomena." *Opera mathematica* (Moguntiae, Sumptibus Antonij Hierat excudebat Reinhardo Eitz, 1612), i, 5: Si vero nobilitas atque praestantia scientiae ex certitudine demonstrationum, quibus utitur, sit iudicanda: haud dubie mathematicae disciplinae inter caeteras omnes principem habebunt locum. [Trans. M. Looney]

and enlighten in a similar way to religious doctrine. Like theology, they possess the gravitational force of their own certain truth. Mathematics, according to Clavius, guides the mind towards stability of thought and clear judgment about all things. As with theological doctrine, it transcends the plane of material reality.

Theology, known from antiquity as the queen of the sciences, occupied primacy of place in the traditional scholastic curriculum because the object of its study is God. Philosophy, the handmaiden to theology, occupied second place because of the support it gave to theology in the hierarchy of studies. Mathematics as a discipline was recognized as playing a supporting role in natural philosophy, music, optics and astronomy. Clavius radically changed this ordering in establishing mathematics as a discreet part of the hierarchy of the sciences and presented the study of mathematics and the new sciences as an independent category of study. He explains in a letter to Emanuele di Savoia written in 1574 that, based on the definition of Aristotle, the nobility of doctrine contained in the mathematical disciplines is derived from the "dignity bestowed by rational demonstration" and because of their inherent nobility, "seem not so much to persuade as to compel by force…." He writes:

> And if (as with Aristotle and his followers), the nobility of doctrine depends both from the dignity of the things [studied] and from the dignity bestowed by rational demonstration, what must be thought of the mathematical disciplines, which – to say nothing of the pre-eminence of the things they treat – have such solidity in their reasonings that they seem not so much to persuade as to compel by force. [267]

[267] Christoph Clavius a Emanuele Filiberto di Savoia, Roma 1 febbraio 1574, *Correspondenza* Vol. II-IV, eds. Ugo Baldini e Pier Daniele Napolitani (Pisa: Universita di Pisa, 1992), 15. Quod si (ut est apud eundem peripateticae disciplinae principem) doctrinarum nobilitas tum ex rerum dignitate, tum ex elaborata probandi ratione pendet; quid de mathematicis disciplinis existimandum est, quae ut de rerum praestatia nihil dicam, tantam habent suis in rationibus firmitatem, ut non tam persuadere, quam vim quodammodo afferre videantur. [Original Trans.: M. Looney], [Corrected trans.: Fr. R. Krishna, O.P.]

Both the dignity of the thing studied and its capacity for rational demonstration make the study of mathematics and the new sciences a *noble doctrine* that is worthy of pursuit for its own sake. In the same letter, Clavius emphasizes that the mathematical disciplines provide stability in explanation, supersede sense knowledge and enable clearer perception and judgement. Employing a mechanical simile, he explains:

> For who upon reading the books of Archimedes, Apollonius, and other mathematicians does not admire the genius of these most acute men, and [who] does not sense, certain of the machines, as it were, of their minds being moved, so that they are compelled even unwittingly to assent to those things which these people put forward. Indeed, it is scarcely possible to describe how much pleasure our mind derives in it [mathematics], so it also persists in judgment and plainly perceives and understands everything, so that it neither inclines to the more doubtful, nor sways, nor is it imbued with error.[268]

Here, Clavius suggests that the minds of the great mathematicians of antiquity were by their training, more stable and reliable because they relied on the certainty of mathematics.

Clavius' textbooks, correspondence, prefaces and dedications presented mathematics and the new sciences as credible in themselves and worthy of study for their own sake. His insistence upon their reliability, stability and certitude remained constant throughout his entire career. In his *Prolegomena* to the *Opera mathematica* (1611) written the year before his death, Clavius reaffirmed once again that the theorems of Euclid retained the capacity to foster the truth through firm and certain demonstration:

> [T]he theorems of Euclid and the rest of the mathematicians, still today as for many years past, retain in the schools their true purity, their real *certitude*, and their strong and firm demonstrations….And thus so much do the mathematical disciplines *desire, esteem and foster the truth* that they reject not only whatever is false, but

[268] Ibid., 15. Quotus enim quisque est, qui Archimedis, et Apollonii, caeterorumque Mathematicorum libros legens acutissimorum hominum non admiretur ingenia, et menti suae firmissimas quasdam quasi machinas admoveri non sentiat, ut iis quae illi tradunt, vel invitus assentlrl cogatur? Qua quidem ex re dici vix potest, quantam animus noster capiat voluptatem, dum ita in sententia perstat, remque omnem plane percipit, ac tenet, ut neutram in partem dubius inclinet, nusquam fluctuet, nedum falsis opinionibus imbuatur. [Trans. M. Looney]

> even anything merely probable, and they admit nothing that does not lend support and corroboration to the *most certain demonstrations*. So there can be no doubt but that the first place among the other sciences should be conceded to mathematics.[269]

Clavius consistently maintained that among the sciences mathematics should be first because of its capacity to reject whatever is false or merely probable and lend support to certain demonstration. In claiming that mathematics rejects not only false but even merely probable things, Clavius raises an anti-rhetorical argument that mathematics deals with only certain things while rhetoric rests its premises on those things which are probable. Mathematics, like noble doctrine, removes uncertainty, fosters truth, and brings clarity of thought and stability in judgement, making it worthy of a place in the hierarchy of learning in the curricula of the Jesuit schools.

Mathematics as useful and necessary

Clavius' insistence upon the study of mathematics and the new sciences as independent disciplines is further illustrated in his commentary on *Proclus*, where he describes mathematics as not only certain and stable, but *useful*. He cites examples from antiquity where mathematicians used mathematics to supply practical solutions at critical moments in history. Even the physical might of all the Syracusans was an insufficient match for the powers of one geometrician:

> When Hieron, King of the Syracusans was to build a ship that he intended to send to Ptolemy, King of the Egyptians, it was so heavy that even all of the Syracusans working together were unable to move it from its place: Archimedes, most skilled in geometry, promised the king that he would ensure *by the powers of geometry* alone that the king himself could move the ship without any effort. When he carried

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[269] Christopher Clavius, *Prolegomena in Opera Mathematica Vol 1,* (Roma: Moguntiæ, 1611*), 5.* Theoremata enim Euclidis, caeterorumque Mathematicorum, eandem hodie, quam ante tot annos, in scholis retinent veritatis puritatem, rerum certitudinem, demonstrationum robur, ac firmitatem …. Cum igitur disciplinae Mathematicae veritatem adeo expectant, adamant, excolantque, ut non solum nihil, quod fit falsum, verum etiam nihil, quod tantum probabile existat, nihil denique admittant, quod certissimis demonstrationibus non conferment, corroborentque, dubium esse non potest, quin eis primus locus inter alias scientias omnes fit concedendus. [Trans. M. Looney] Italics mine.

> this out, in the view of everyone the King is said to have exclaimed, with astonishment: From this day on, *whatever Archimedes says, he is to be believed*.[270]

In this case, the mathematician Archimedes, armed with the power of geometry, was able to do what all the mighty Syracusans were unable to accomplish. This won for him *esteem* and the distinction of being seen as *credible* in the eyes of the king and of all. Here, Clavius could speak with authority about the importance of solving a king's problem and securing credibility for oneself. His participation in Pope Gregory's reform of the calendar had given him first-hand experience of the benefits associated with providing a practical solution to solve a royal, or papal problem.

Clavius established a bridge between the old and new, between tradition and innovation, by using lessons from antiquity to demonstrate the power of mathematics and the new sciences. He wisely employed the authoritative weight of an antique source to illustrate the *usefulness* of mathematics and showed that mathematics solves not only the logistical problem of moving a ship but is also useful for important, diplomatic matters of state. As Archimedes' command of geometry impressed the king and earned for him universal credibility among the Syracusans, Clavius' students could earn the respect of their colleagues and superiors by using their mathematical ingenuity and intelligence to solve problems. In *De Mathematicis*, Clavius expands this notion by showing there is virtually no practical or speculative discipline that is not ennobled by mathematics:

> For indeed, the mathematical disciplines supply and explain to the poets the rising and setting of heavenly bodies; to historians the shape and distance of places; to

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[270] Christoph Clavius, *Euclidis Elementorum* libri XV, 1574 (Colonaie : Apud G. Cholinum, 1607), Prolegomena, 7. Cum enim Hieron Syracusarum Rex nauem quam Ptolemaeo Aegyptiorum Rege mittere stateurat tanitae esset molis fabricatus ut eam omnes una Syracusij a loco dimouere menome valerent: Archimedes geometra peritissimus unius geometriie viribus fretus Rege promisit se effecturum ut ipsum solus Rex absare ullo labore subduceret. Quod cum praestitisset in conspectu ommium Rex stupefactus exclamasse perhibetur: ab hac dic quidquid dixerit Archimedes, illi credendum est. [Trans. M. Looney] Italics mine.

> those who analyse (analyticis) examples of solid proofs (demonstrationes); to political leaders easily admired techniques to manage both domestic and military affairs well; to physicists the forms and distinctions of heavenly revolutions, of light, of colours, of transparent media, of sounds; to metaphysicians the number of spheres and intelligences; to theologians the major parts of the divine handiwork; to law and ecclesiastical custom the accurate reckoning of time. For the meantime, we pass over the benefits which flow to the republic from the labor of mathematicians in the healing of diseases, in voyages by sea, in the pursuit of farmers. Therefore, an effort must be made so that, just like the other disciplines (facultates), mathematics also may flourish in our schools (gymnasiis)….[271]

Clavius' participation in the Gregorian reform of the calendar secured his confidence that mathematics could be applied to a sphere beyond ecclesial circles. The clarity and certitude of mathematics serves to stabilize and preserve civic society. It extends beyond itself and touches all spheres of life: it enlightens poets, philosophers and theologians, heals diseases (such as the plague), guides seafaring merchants and missionaries across rough waters, and maintains an ordered, peaceful society through enhanced military technology.[272]

Mathematics as brilliant, contemplative, pleasing, edifying

Clavius presents mathematics and the new sciences as noble doctrines that are credible in themselves. They are rational and useful but are also attractive, and because of their beauty, they elevate minds and hearts to the contemplation of celestial realities. In the *Prologema,* Clavius observes that the study of mathematics, at its most basic, is entertaining and pleasurable. But by

[271] Christopher Clavius, *De Mathematicis, Monumenta Paedagogica Societatis Iesu* (1586), ed. Ladislaus Lukacs (Rome: Institutum Historicum Societatis Iesu, 1965), 109. Illae namque suppeditant atque exonunt poetis ortus occasusque syderum, historicis locorum facies atque intervalla; analyticis solidarum exempla demonstrationum, politicis artes plane admirabiles rerum bene gerendarum domi militiaeque; physicis coelestium conversionum, lucis, colorum, diaphanorum, sonorum formas et discrimina; metaphysicis sphaerarum atque intelligentiarum numerum; theologis praecipuas divini opificii partes; iuri et consuetudini ecclesiasticae accuratas temporum supputationes. Ut praetereantur interea, quae ex mathematicarum labore redundant in rempublicam utilitates in morborum curationibus, in navigationibus, in agricolarum studio. Conandum igitur est, ut sicut facultates caeterae, ita et mathematicae in nostris gymnasiis floreant… [Trans. M. Looney].

[272] See p. 72 for Dennis DeLucca's treatment of Jesuit military fortifications.

its order and brilliance, mathematics also liberates, delights and fulfils souls of all ages and states in life:

> Indeed they, among the seven liberal arts, are special because they strongly move toward great glory and delightful freedom the souls not only of sincere youths, but also of noblemen, princes, kings, and emperors. Of all these benefits [of mathematical studies] perhaps the greatest is the entertainment and pleasure that fills the soul as a result of the cultivation and exercise of those arts. [273]

This delightful freedom of the soul that is liberated by the study of mathematics is a universal experience that is available to all: "sincere youths… noblemen, princes, kings, and emperors"; like noble doctrine, it can purify and lift the mind and heart to heavenly realities. In a letter to the Duke of Bavaria, Wilhelm von Bayern in 1570, Clavius draws a more direct correlation between the study of the light, motion and the power of heavenly spheres, and the contemplation of the infinite power of God:

> Not only are there in this universe many things which are put before the eyes and senses of human beings, by which mortal flesh could rise from the muddy path to the contemplation of their Maker, but also the form and beauty and bulk itself of heavenly bodies and of the stars of such a kind as to carry and lift up with great ease the minds and souls of those who gaze on them from earthly and impure thoughts to sublime and joyful ones. For although God, being supreme even in the smallest things, shows his benevolence and his strength everywhere by filling all things with his radiance, nonetheless, those things which one beneath the moon are frail and transitory, and found to perpetual change, point to the perfect and absolute nature of his eternal mind, to the extent, although with slight traces.[274]

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[273] Christopher Clavius, *Prologema Opera Mathematica,* (Roma : Moguntiæ, 1611*), 6*. Sunt enim hae praecipue ex septem artibus liberalibus, in quibus non solum ingenui adolescentes, verum etiam nobiles viri, principes, reges ac imperatores ad honestissimam, maximequae; liberalem oblectationem animi, quam summa etiam cum utilitate coniunctam pariunt, diu multumque gnam animi voluptem ex his artibus percipi. [Trans. M. Looney].

[274] Christopher Clavius a Wilhelm von Bayern, Roma 20 Marzo 1570 *Corrispondenza* Vol II-IV, 14. Cum in hac rerum universitate innumerabilia pene sunt, oculis hominum sensibusque proposita, quibus humi strata mortalitas ad summi illius opificis contemplationem possit exsurgere; tum caelestium orbium, syderumque species, et pulchritudo ac moles ipsa, est eiusmodi, ut intuentium animos a terrenis, impurisque cogitationibus ad sublimes, easdemque iucundissimas facillime traducat et rapiat. Nam et si Deus in minimis etiam maximus omnia suo implens numi ne, suam ubique vim ac benignitatem ostendit; tamen, haec quae infra Lunam sunt, caduca, ac fluxa, et commutationi perpetuae obnoxia ….qui bus ea cuncta deserviunti sempiternae illius mentis perfectissimam absolutissimamque naturam levibus dumtaxat vestigiis indicant. [Trans. M. Looney].

After providing an eloquent testimony of the sublime power and beauty of mathematics, Clavius laments that, "in this time many are ignorant about the various oppositions, conjunctions, and motions of the stars…."[275] Ignorance of the stars is ignorance of the heavenly realities for Clavius, and more importantly, of the Creator who set all heavenly realities in place. He continues that, "unless freed by the benefit of science"[276] the present generation will be ignorant of both the heavens and the creator of the heavens. He continues that well-trained mathematicians in the Society will instruct others in the mathematical sciences and will gain "from us an admirable knowledge of these things with certainty."[277]

Clavius also encourages the study of mathematics and the new sciences, because he sees mathematics as a powerful tool in bringing others to a true knowledge of God:

> Wherefore, Our Society, embracing all things zealously which seem to be capable of forming young minds towards piety and leading them to true knowledge of God, has not likewise considered as negligible or as only worthy of trifling attention this part of mathematical discipline, which deals with the precise and simple study of the stars and of the heavenly orbs.[278]

In Clavius' estimation, the study of mathematics aligns with the objectives of the Society to "embrace all things zealously." Mathematics is a tool by which young minds will be led to God. Clavius critiques the dismissal of mathematics by some members of the Society, because they have overlooked its capacity to elevate and connect young minds with the inspired thoughts of eternal things, and ultimately the maker of eternal things.[279]

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[275] Ibid., 15.

[276] Ibid., 15.

[277] Ibid., 14.

[278] Ibid., 14. Qua circa, minima quoque haec nostra Societas, omnia studiose complexa, quae iuventutis animos ad pietatem informare, veramque Dei cognitionem perducere posse viderentur; ne hanc quidem mathematicae disciplinae partem, quae in astrorum globique caelestis exacta eademque s implici cor.sideratione versatur. sibi aut negligendam. [Trans. M. Looney]

[279] See: Christopher Clavius a Wilhelm von Bayern, Roma 20 Marzo 1570 *Corrispondenza* Vol II-IV, 14.

Mathematics as Important and Influential

In presenting mathematics and the new sciences as a noble doctrine that is certain and useful, Clavius connects mathematical knowledge with the contemplation of the infinite power of God, presenting the study of mathematics and the new sciences as practically indispensable. His efforts to convince did not go unrewarded. In Europe, Clavius' reputation as a mathematician along with the status of his mathematics academy increasingly attracted attention from influential audiences in secular and ecclesial quarters. Clavius' vast correspondence with colleagues and patrons, his production of commentaries, textbooks and pamphlets, his work on the *Ratio Studiorum*, and the production of elaborate public mathematical demonstrations all played a critical role in garnering enthusiastic and necessary support. Within the Society, Clavius' assertion that mathematics and the new sciences should occupy a prime place of consideration in the Society gained momentum. Mathematical sciences moved from a static component of the quadrivium to a dynamic field of study that was public, well-funded and conscious of its own advancement. For the Duke of Parma's visit to the college, mathematical problems were included with sermons and disputations as part of the program for the day. Marco Garzoni, the rector of the Jesuit College in Parma, noted that:

> The duke had given great honour to all the Fathers of the Congregation … favouring with his personal presence the sermons, the disputes, the mathematical problems, and even the refectory, where he came to have lunch with us.[280]

[280] Quoted in Rivka Feldhay, "The Cultural Field of Jesuit Science," in *The Jesuits: Cultures, Sciences, and the Arts 1540-1773*, eds. John O'Malley, Gauvin Bailey, Steven Harris, and Thomas Kennedy (Toronto: University of Toronto Press, 2015), 112.

The Society's implementation of mathematics and the new sciences allowed them access to influential members of society and served as a means of displaying their knowledge of mathematics and the new sciences in a public way. As with Archimedes and the King of the Syracusans, mathematics and the new sciences were not only useful for demonstration and diplomacy, they could assist rulers in matters of state and governance. A letter from Clavius to the Duke of Savoy, Carlo Emanuele di Savoia I in Torino reinforces the duke's confidence in mathematics as a tool that a "most learned man" could use in the preservation and defense of the city:

> And why shouldn't this highly powerful gift be provided you so that you might be able to put it to use yourself (if indeed something should be called "a gift" when the one who gives it is really a recipient)—since Ioan Baptista Benedictus, that most learned man in mathematical affairs, witnesses that you excel in these arts, especially those aspects which are useful to the most eminent men and excellent leaders for building up armies and fortifying towns.[281]

To be excellent in the mathematical arts was key to good governance for an Early Modern ruler.

As part of a comprehensive strategy, Clavius successfully engaged influential patrons to support his program of study and relied upon these resources to sustain the mathematics academy, its professors, students and library. In the 1580s Clavius had dedicated his defense of the Gregorian calendar to the Holy Roman Emperor Rudolf II, followed by a work on astrolabes for the Duke of Urbino, a commentary on algebra to a Neapolitan nobleman Juan de Guevara, and a book of practical geometry to the German mercantile magnate Georg Fugger. To the Duke of

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[281] Christopher Clavius to Carlo Emanuele di Savoia I in Torino, Roma, l settembre 1589 *Corrispondenza* Vol. II-IV, 1570-1601, eds. Ugo Baldini E Pier Daniele Napolitani (Pisa: Universita Di Pisa 1992), 112. Quod cum ita sit quidni hoc tibi potissimum deberetur donum (si tamen donum dicendum est id, quod qui dat, videtur accepisse) quem Ioan Baptista Benedictus scientiss. rerum Mathematicarum ita testatur excellere in his artibus, illa praecipue in parte, quae principes viros, atque excellentes imperatores decet ut ea, quae pertinent ad instruendos exercitus, oppidaque munienda, per te ipse implere possis. [Trans. M. Looney].

Urbino, Francisco Maria, Clavius paid homage to the duke's alleged appreciation of mathematics and the sciences: "To whom could I more justly dedicate my discoveries [on the astrolabe] than to you who are excellent beyond the rest with respect to your cognization of mathematics?"[282] Dedication pages often included a genealogy of the patron's lineage, as seen in Riccioli's *Almagestum Novum* (1651), which contained a nine page folio for Cardinal Grimaldi and Prince Onoratus II of Monaco.[283] Clavius dedicated his *De Gnomonica* to Stephen, the King of Poland, stating that his motive for dedicating a scientific treatise to the King of Poland was not necessarily due to the king's influence in matters of mathematics or the new sciences, but because of his *zeal for religion* and desire to propagate it:

> I do not doubt that some do not approve of the fact that I decided to dedicate my work *De Gnomonica* especially to you. […] is that he sought with great zeal to protect and spread the Catholic religion. Accept therefore this, our work, whether as the remembrance of a grateful soul, the pledge of faith, or the testimony of reverence.[284]

The decision to remember the king of Poland in a dedication was not without forethought; the Jesuit mission in Poland had begun with difficulty and relations were just beginning to improve at the time of Clavius' publication of *De Gnomonica*.

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[282] Christoph Clavius a Francesco Maria Della Rovere [in Urbino], Roma 3 settembre 1593, *Correspondenza* Vol. II-IV, #90, 31-33. [Trans. M. Looney].

[283] See Giovanni Battista Riccioli, *Almagestum novum astronomiam veterem novamque complectens* (Rome: Bononiae Libris, 1651).

[284] Christoph Clavius a Stepan Bathory, Rome, l aprile 1581, *Correspondenza* Vol. II-IV, #13, 29-31. Quod meum hoc opus de Gnomonica tibi potissimum dicare constituerim, rex potentissime, non dubito, quin aliqui minus probent. [….] quo clarius apparet, eum ab ardenti quodam Catholicae relgionis tuendae, ac propagandae studio proficisci. Aciipe igitur nostrum hoc sive grati animi monumentum, sive fidei pignus, sive observantiae testimonium. [Trans. M. Looney].

Polite Conversations

The Jesuits were not alone in using mathematics and the new sciences to engage in a non-controversial manner. The neutrality of the mathematical sciences allowed for conversational exchanges with influential members of society that circumvented the tensions associated with an era of confessional strife. Thomas Sprat recorded that the members of the Royal Society gathered for the "Satisfaction of breathing a freer Air, and of conversing in Quiet one with another, without being ingag'd in the Passions and Madness of that dismal Age."[285] Mathematics and the new sciences provided the Jesuits with material for conversations that allowed them to secure their credibility and avoid unintended controversy among sympathetic, educated audiences. In Clavius proposes that conversations in mathematics and the new sciences would create an opportunity for the Jesuits' religious message to be more amenably received, and would provide a venue for the Society to enhance its credibility through conversations with what he refers to as "leading men." This display of intellectual talent among the men of the Society in the presence of influential members of society would draw the eyes of all to the Society:

> [T]here is no one who does not perceive how much it is central to every objective of the Society to have some men who are most outstandingly erudite in these minor studies of mathematics, rhetoric, and language, which people now frequently talk about, who would spread the eminent reputation of the Society far and wide, unite the love of noble youths, curb the bragging of the heretics in these arts, and institute a tradition of excellence in all those disciplines in the Society.[286]

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[285] Quoted in F. P. Wilson, "English Letters and the Royal Society in the Seventeenth Century," *The Mathematical Gazette* 19 (Dec. 1935), 346.

[286] Christoph Clavius, *Discursus cuiusdam amicissimi Societatis Iesu de modo et via qua Societas ad maiorem Dei honorem et animarum profectum augere hominum de se opinionem, omnemque haereticorum in literis aestimationem, qua illi multum nituntur, convellere brevissime et facillime possit*, 1594, *Monumenta Paedagogica Societatis Iesu* vol. VII, ed. Ladislaus Lukács (Rome, Institutum Historicum Societatis Iesu, 1965): 119-122. Iam vero, quanti intersit ad omne propositum Societatis habere in his minoribus studiis, quius plurimum deferent nunc homines, mathematicae, rhetoricae, linguarumque aliquos valde insigniter eruditos, qui eminentes caeteris famam Societatis longe diserminent, amorem nobilioris iuventis concilient, haereticam in his artibus iactantiam compescant, et ipsus Societatis sobolem ad omnem harum rerum excellentiam instituant, nemo est, qui non perspiciat. [Trans. M. Looney].

Training men to be conversant in mathematics would extend the Society's excellent reputation as educators and perhaps more importantly, provide a useful weapon to combat the badgering of heretics against the Society and the Church. The use of reason, drawn from mathematical demonstration, served as an apologetic weapon to contend with "heretical laymen for the attention of Catholic princes,"[287] and enhanced the epistemological credibility and prestige of the Society. Clavius also unapologetically promoted the use of mathematics in "curb[ing] the bragging of the heretics in these arts."[288]

In the same document in which he argues the importance of mathematical instruction as a means of securing a lasting reputation for the Society, Clavius asserts that the opposite, a lack of erudition in these matters, provides an opening for opponents to influence and draw away youth from the Church. In *Modus quo disciplinæ,* Clavius observes that the inability of the Society's priests to be conversant in the mathematical questions of the day was a deficiency that hindered their efforts to remain credible in the eyes of contemporaries:

> In order that the Society is always able to have capable professors of these [mathematical] sciences, some men apt and capable of undertaking this task ought to be chosen who may be instructed in a private academy in various mathematical topics . . . *they are a great ornament to the Society*, and quite frequently a discussion about [mathematical sciences] will occur in conversations and meetings of leading men, where they might understand that ours are not ignorant of mathematical topics. Whence it happens that in such meetings our people necessarily become silent, not without great shame and disgrace; as those to whom this very thing has happened have often reported.[289]

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[287] Clavius, *Discursus* 120.

[288] Clavius, *Discursus,* 122.

[289] Christopher Clavius, *Modus quo disciplinæ mathematicæin scholis Societatis possent promoueri, Monumenta Paedagogia Soceitatis Iesu* vol VII*,* ed. Ladislaus Lukacs (Rome: Archivum Romanum Societatis Iesu, 1965) #34, 116. Ut autem Soceitas semper habere possit idoneos harum scientiarum professores, eligig deberent aliquot ad hoc munus obeundum apti 12 idonei, qui in privata academia instituerentur in variis rebus mathematicis, alioquin non videtur posse fieri, ut haec studia in Societate diu permaneant, nedum promoveantur ; vel et magnum Societati afferant ornamentum, ut requentissime in colloquiis et conventibus pricnipum virorum de illis sermo habeatur, ubi intelligunt nostros mathematicarum rerum non esse ignaros. Unde fit, ut necessario nostri in eiusmodi conventibus obmutescant, non sine magno rubore atque dedecore. [Trans. M. Looney]

Clavius recounts the "shame and disgrace" that befalls the Society when members are unable to engage intelligently in mathematical conversations, which "quite frequently…occur in conversations and meetings of leading men."[290]

Ignatius encouraged his first followers to send to him detailed accounts of natural phenomena for the "edification" of the "leading figures" in Rome.[291] Clavius employed a parallel strategy for the edification of influential and important men of his own time. Ignatius suggested that "this news [is a] sauce for the taste of a certain curiosity,"[292] for the leading men of Rome, but for Clavius the need for skilled knowledge of this kind was more imperative than the need to satisfy curiosity. Knowledge of the mathematical sciences leveraged the *credibility* of the Society and reinforced the message of the Catholic Reformation. In the *Discurses,* Clavius states that if the Society were to establish a reputation for being learned in all areas, especially mathematics, it would contribute to the work of rebuilding the Catholic faith and gain ground already surrendered in the battle for souls:

> I believe it to be so ordained by nature that eminence in any subject, even of the least importance, *causes the eyes of everyone to converge on oneself* . . . It is for this reason that in these times many Catholics have surrendered their sons by the reputation of more excellent erudition to be instructed and lost to heretics….[293]

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[290] Ibid., 116.

[291] Ignatius to Gaspar Barzaeo, 24 February 1554, Monumenta Ignatiana. Epistolae et Instructions (Madrid: Gabrielis Lopez del Horno, 1907), 358. Y esta salsa, para el gusto de alguna curiosidad que suele hauer en los hombres, no mala, puede uenir, ó en las mesmas letras, ó en otras de aparte. [Trans. mine]

[292] Ignatius to Gaspar Barzaeo, 24 February 1554, *Monumenta Ignatiana. Epistolae et Instructions* (Madrid: Gabrielis Lopez del Horno, 1907), 358. [Italics mine]

[293] Clavius, *Discurses.* 121. Cum ego iam constet, eminentiam in re qualibet observari maxime a mortalibus, quippe quae in aures remotissimorum incurrit, et omnium animos ad se pertrahit ; videammus quae sit expeditor ad eam emita, et sur tantis dificultatibus obsessa, ut paucissimi multis saeculis ad eam pertingant...Quidam enim, cum sui iuris sint, hoc est liberi, et nullius subsint imperio, animusque rerum varietate delectetur, unius rei studium ferre non possunt, sed exuent in omnia quae sensibus occurrunt. Qui ubique est, nusquam est. Alii, cum commodum et lucrum sequantur, non iis studiis insistunt maxime, quibus maxime sunt idonei, sed quae maxime utilia fore confidunt. [Trans. M. Looney] Italics mine.

In a relatively brief treatise (five pages), Clavius articulates his concern in the *Discurses* multiple times, saying that if the *reputation* for credible erudition of the Society is not maintained, "despicable falsehoods" will continue to propagate. The men of the Society "for the glory of God and the advancement of souls — can *increase men's opinion about them* […] and can quickly and easily overturn men's admiration for the heresies upon which they have relied so much."[294] Clavius argues that it is "ordained by nature" that erudition in any subject causes all eyes to look to that source for credible answers. If the Society maintained a credible reputation as a reliable authority in all matters, then even those who had drifted away from the Catholic Church would be convinced that the Society (and by extension, the Church) possessed the truth in matters of greater and lesser importance. From the *Discursus*:

> [S]o much authority would be gained among multitudes of people living far away, that either those hesitating in their Catholic belief will be held back, or those that have entered into heresy will be called back, persuaded by that *sole argument that they will esteem that with men so learned*, in such large numbers, and pleading with such unanimous consent, ignorance of the truth cannot possibly exist.[295]

By this means, learned men who were equipped with the truth would persuasively present the truth to others and compel those who had drifted away to turn from error.

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[294] Clavius, *Discurses*, 120. Discursus cuiusdam amicissimi Societatis Iesu de modo et via qua Societas ad majaiorem Dei honorem et animarum profectum augere hominum de se opinionem, omnemque haereticorum in literis aestimationem, qua illi multum nituntur, convellere brevissime et facillime possit. [Trans. M. Looney].

[295] Clavius, *Discursus,* 119. Magna aestimatio Societatis Iesu quam habet apud exteras, longeque positas regiones fere exisit a literis universa. Nam, si qu creditur singularis morum probitas, ea nonnisi a coniunctissimis perspecta, a plurimis ignoratur, et communis cum aliis religiosis existimatur. At vero, laus elegantioris eruditionis, cum caeterae religiones barbarae putentur, huic etiam inimicorum consensu tribuitur maxima ; qua una et sola re tantum auctoritatis apud multos homines remotissime degentes acquisivit , ut eos vel haesitantes in fide catholica retinuerit, vel ingressos haeresim revocaverit eo solo persuasos argumento, quod existiment, viris tam doctis, tam multis, tam unanimi consensu asseverantibus, ignorationem veri inesse non posse. [Trans. M. Looney].

Mathematics as Vocation and Mission

Clavius campaigned for the study of mathematics and the new sciences because he believed that they were worthy of study for their own sake, they contributed to all areas of society, drew others to celestial realities and by their beauty, ultimately pointed to the Creator of the heavens. Finally, Clavius extends this argument further by presenting the teaching of mathematics and the new sciences as a *chosen ministry* to be exercised by those who are called to participate in a special "vocation" within the Church. As mentioned in the previous chapter, Clavius envisioned a corps of mathematicians who would be trained to facilitate encounters between the truths of mathematical sciences and the sublime realities of the heavens. These were not ordinary teachers, but men selected by their superiors at the Collegio Romano and set aside for a chosen work within the Society. The vocation of the priest-mathematician and priest-scientist was to carry out a sort of "mission within a mission" and to disseminate truth through the certifiable knowledge of mathematics.

The first Jesuits who were chosen for ministry in foreign territories transcended the traditional boundaries of the missionary commitment by exchanging their native cultures for the host communities they served. In *De Re Mathematica Instructio,* Clavius uses the word "ministry" three times to describe the vocation of teaching mathematics and speaks twice of being "chosen for ministry."[296] This chosen vocational missionary identity is reinforced by a rigorous admissions process and special accommodations that were reserved for Clavius' select students in the academy. Clavius summoned "the most talented men (among whom are those who for greater service of our Lord and the good of the Society should be chosen for a ministry such as this),"[297]

[296] Christopher Clavius, *De re mathematica instructio* (1593) trans. D. Smoloski, *Monumenta Paedagogia Societatis Iesu*, Vol. VII, ed. Ladislaus Lukács (Monumenta Historica Societatis Iesu, 1965), 117-118.

[297] Ibid., 117. illud unum ea in re videtur esse incommodi, quod, cum admodu adolescentes, plerumque ingeniosissimi quique, et ii, quos ad maius Domini nostri servitium ac Soceitatis bonum ad tale ministerium seligi

for specialised study. In addition, he advocated that men who were "chosen for this ministry [of teaching mathematics]" should assume leadership in the program, "men who are already of a mature age, both priests and theologians, [who] would give honour to a chair [of mathematics]."[298]

Next, Clavius moved beyond speculative suggestions to the outline of a program for practical implementation. In *De re mathematica instructio,* he calls for a time of dedicated study for mathematics and the new sciences. This is a response to what he sees as a general lack of academic preparation by the men of the Society. In this current state, Clavius writes that the men are able to "attain a moderate knowledge of many things, [while] very few attain excellent knowledge of even one."[299] To remedy this, he advances a proposal that requires an extra year of study of mathematics for seminarians who are preparing to be ordained priests, "…for the advancement of mathematical studies in our Society, which were already almost neglected…"[300] He adds that after the first course of philosophy, "they might study this [science] more thoroughly at home, and then teach publicly for one or two years."[301]

As Jesuit priests became trained in the special vocation of mathematician or scientist and were equipped with the necessary knowledge to impart noble doctrines to others, the next step for the priest-mathematician or priest-scientist was to be sent out into the world. In *De Mathematicis,* written for the *Ratio Studiorum* of 1586, Clavius' envisioned that in the full exercise of this

oporteret, philosophiam absolvant, cum, ut plurimum, qui aetate maxime praecesserint, quartum et vigesimum annum vix attigerint, neque ipsis expedire videtur, ut annum eum, quo docent, cum unius aut alterius horae spatium ministerium id requirat... [Trans. M. Looney].

[298] Ibid., 117. [D]einde vero, audire theologiam, tum vero docere id temporis, quod ante docturi essent, mathematicas disciplinas. Nam, praeterquam quod, iam matura aetate viri ac sacerdotes et theologi cathedram cohonestarent potius, quam deprimerent... [Trans. M. Looney].

[299] Ibid., 117.

[300] Ibid., 117. Actum est anno superiore, ut ad promovenda in Soceitate nostra mathematicae studia, quae pene iam negligebantur...

[301] Ibid., 117. [I]I qui eam scientiam profesuri essent, a docenda grammatica ea ratione exime erentur, ut primum annum, post peratum philosophiae curriculum, domi eam plenius audirent; tum vero uno aut latero anno publice profiterentur. [Trans. M. Looney].

ministry, the men of the Society would disseminate mathematical knowledge to all the provinces. In speaking about mathematics, they "will uphold our (the Society's) reputation."[302] Clavius prophesied that the sending forth of the priest-mathematicians and priest-scientists from the academy in Rome to the remotest parts of the earth would bear fruit:

> Afterwards, the excellent mathematicians of this academy will go forth, who will disseminate this discipline into all provinces to which they will return, and they will uphold our reputation, if at any time it behoves them to speak about mathematics.[303]

As these mathematical missionaries were sent forth equipped with the authority to speak, with proper preparation and masters to guide them, they would enable the proper conditions for the:

> Society of Jesus [to] have brilliant and most eminent men. When they are distributed in various nations and kingdoms like sparkling gems these will be a source of great fear to all enemies, and an incredible incitement to make young people flock to us from all the parts of the world, to the great honour of the Society.[304]

As the men of the Society were distributed throughout the world "like sparking gems," the reputation of the Society would be upheld, fear would be incited in the hearts of enemies and many youths would be drawn to the truth. More Jesuit priests would become trained in the mathematical sciences, and the depth of knowledge, expertise and the effectiveness of the priests' missionary efforts would increase proportionally. Clavius believed that once mathematicians were sent forth from the Roman core, chosen ministers of his academy

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[302] Ibid., 117-118

[303] Christopher Clavius, *De Mathematicis*, *Monumenta Paedagogica Societatis Iesu*, eds. Ladislaus Lukacs (Rome: Institutum Historicum Societatis Iesu, 1965), 110. Porro ex hac academia eximii prodirent mathematici, qui eam facultatem in omnes provincias, ad quas essent reversuri, disseminarent, et nostrorum tuerentur existimationem, siquando oporteret eos de mathematicis respondere. [Trans M. Looney].

[304] Quoted in Michael J. Gorman, "From the eyes of all to usefull quarries in philosophy and good literature: consuming Jesuit Science" in *The Jesuits: Cultures, Sciences, and the Arts, 1540-1773* edited by John W. O'Malley, Gauvin Alexander Bailey, Steven J. Harris, T. Frank Kennedy, (Notre Dame: Notre Dame Press, 2016), 113.

would promote mathematics and the new sciences and ensure the credibility of the Society and the Church among their peers in Europe and abroad.

Conclusion

Clavius' vision, and perhaps more importantly, his keen sense of timing, ensured a prominent place for the study of mathematics and the new sciences in the new pedagogical plan for the Society. Beyond that, mathematics became a critical component of the Jesuits' Catholic Reformation strategy. Clavius was confident that mathematics was worthy of study for its own sake; a noble doctrine that was brilliant and edifying, attractive and influential, useful in the face of the adversary, necessary for the preservation of civic society and worthy of a missionary vocation. Once trained and sent, these mathematical missionaries would use their expertise and specialized knowledge to draw others to the Society and to the Church through their clarity, objectivity and elocution.

Clavius believed that the mathematical sciences served as ideal tools for the missionary: they were certain, easily exportable and possessed a universality that allowed for easy passage across linguistic and cultural borders. To the educated and uneducated, elite and underprivileged, the mathematical sciences were novel and fascinating, and the Jesuits were adept at accommodating their approach according to the needs of their audience. Fluency in matters of natural philosophy and scholastic theology sustained the interest of select scholars in the field, but the new sciences drew immediate attention through their natural attraction, appeal to order, inherent beauty, capacity to delight audiences and useful application.

Clavius' plan for world evangelization through mathematics and the new sciences created a movement within the Society and the Church that was unique and unrepeatable. As Clavius' program continued to gain momentum, however, a new challenge loomed on the horizon as the Jesuits invested themselves with increased energy and conviction in promoting mathematics and the new sciences. The chapters that follow discuss the challenges the members of the Society experienced in implementing the mathematical sciences as a novel and effective tool for evangelization, particularly during a time when reconciling the tradition of the Ancients with the works of the new sciences was met with new challenges. As they continued to pursue mathematics and the new sciences as a missionary strategy within the context of the Copernican Revolution and the Protestant Reformation, the Jesuits became increasingly entangled in the complex enterprise of reinforcing their credibility through innovative methods while maintaining a position of Catholic orthodoxy within the cultures they served.

Chapter Six
An International Network of Priest - Mathematicians

According to the disposition of Divine Providence, various ways been employed at different times, and with different races to interest people in Christianity. In fact, this very attraction was to draw many of the Chinese into the net of Peter.
- Matteo Ricci[305]

Clavius' vision for the promotion of an international network of Jesuits who were priests and men of the new sciences unfolded with a premise that mathematics, in itself, is worthy of study. Like theological doctrine, mathematics possessed qualities that made it a noble doctrine, capable of imparting certain knowledge, enlightening darkened intellects, and stabilizing thought. Clavius appealed to the aesthetic qualities of mathematics, writing that they are brilliant and edifying and raise the mind and heart to the contemplation of celestial things. The delightfulness of mathematics liberated the soul and drew the mind to greater magnitudes, to the heavens and ultimately to the Creator of the heavens. He argued that mathematics was attractive to all ages but particularly to youth, and that the mathematical sciences could be used to influence leading men in society. The credibility gained through mathematics could draw others to the Society and confound heretics and the enemies of the Church. It was useful in solving important problems that

[305] Matteo Ricci, *China in the Sixteenth Century: The Journals of Matteo Ricci: 1583-1610*. Trans. Louis J. Gallagher, S.J., New York: Random House, 1953, 166.

troubled prelates and kings, including matters that impacted upon society and the health and welfare of its citizens. The self-evident power of mathematics, Clavius concluded, made it useful and necessary as part of the Jesuits' Catholic Reformation strategy.

From this platform, Clavius campaigned that students at the Collegio Romano, particularly young priests in formation, should be trained in mathematics. Once trained, young Jesuits armed with erudition and mathematical knowledge would go forth with confidence and draw potential converts to the Society and the Church. To bolster the narrative, Clavius cautioned what the potential counter-effect of neglecting to act in this manner would be: in places where there was an absence of men in the Society who were trained in the mathematical sciences, a lack of zeal for excellence in the mathematical sciences would create an opening for the opponents to gain ground. Clavius' solution was to form a chosen ministry to be carried out by mathematical missionaries who were defined by a rigorous admissions process and demanding program of study in mathematics. Once the priest-mathematicians were prepared for the mission field, Clavius was certain that they would "shine forth like sparkling gems and incite young men to flock to the Society from all over the world."[306]

Appeal of the new sciences

The new mathematical sciences were attractive and intellectually satisfying in themselves and were more accessible than ancient and medieval natural philosophies. Scholastic philosophy's long affiliation with the Catholic Church had limited attraction for post-Reformation audiences,

[306] Quoted in Michael J. Gorman, "From the eyes of all to usefull quarries in philosophy and good literature: consuming Jesuit Science" in *The Jesuits: Cultures, Sciences, and the Arts, 1540-1773* edited by John W. O'Malley, Gauvin Alexander Bailey, Steven J. Harris, T. Frank Kennedy, (Notre Dame: Notre Dame Press, 2016), 113.

and was tainted by association with universities that had historically been sponsored by the Church. The alignment of scholastic philosophy with Catholic-Thomistic doctrine made it suspect to non-Catholic audiences. A dearth of recent development in natural philosophy separated it from the rapid progression of innovations and inventions that marked early modern natural philosophy in fields as varied as optics, magnetics, astronomy, mechanics, and the tools and techniques of technology.

The unveiling of inconsistencies within ancient philosophical systems shifted the confidence of Early Modern mathematics from natural philosophy to the mathematical sciences. Nearly a century after the publication of *De Revolutionibus*, a publisher's note to a 1638 edition of Galileo's *Dialogues* echoed the Society of the Antiquities' charter that sought to separate "falsehood from truth and tradition from evidence" and to "sift history by the sagacity of modern criticism . . . wherein every part of science is advancing to perfection. . . .[307] It reads:

> Praise and admiration are likewise due to those clever intellects who, confining their attention to the known, *have discovered and corrected fallacies and errors in many and many a proposition enunciated by men of distinction and accepted for ages as fact*. Although these men have only pointed out falsehood and have not replaced it by truth, they are nevertheless worthy of commendation when we consider the well-known difficulty of discovering fact. . .. And indeed, these latest centuries merit this praise because it is during them that the arts and sciences, discovered by the ancients, have been reduced to so great and constantly increasing perfection through the investigations and experiments of clear-seeing minds. This development is particularly evident in the case of the mathematical sciences. [308]

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[307] "[T]o contribute to separate falsehood from truth and tradition from evidence; to sift history by the sagacity of modern criticism, in an age wherein every part of science is advancing to perfection, and in a nation not afraid of penetrating into the remotest periods of their origin, or of deducting from it anything that may reflect dishonour to them." Taken from the 1572 Charter of the Society of Antiquaries in *Archaeologia,* London, Vol. 1 (1770). Quoted in Silvio A. Bedini, Silvio A. "The Evolution of Science Museums." Technology and Culture 6, no. 1 (1965), 9.

[308] Publisher's Preface to the Reader, *Galileo Galilei, Dialogue of Two World Systems, 1638*, Translated from the Italian and Latin into English by Henry Crew and Alfonso de Salvio. Introduction by Antonio Favaro (New York: Macmillan, 1914), xx.

Methodology, experimentation and technology made it possible for practitioners of the new sciences to make known those things that had been masked from the Ancients' understanding. Men of the new science, possessed of "clear-seeing minds", were restoring the sciences to their original integrity and re-introducing a new light of understanding that separated falsehood from truth and tradition from evidence. Concurrently, the Jesuits were forming their own version of the "man of the new sciences," whose life and vocation was dedicated to the pursuit of sophisticated, specialized knowledge. This knowledge was distinguished from general scholarship, easily exportable and had the capacity to be communicated and commodified in a way that separated it from Aristotelian science.

As Clavius predicted, an international corps of priest-mathematicians and priest-scientists *did* materialize, and by the middle of the sixteenth century, Jesuit science had disseminated through the Society's vast network. The scale and scope of the network coupled with the Jesuits' reputation for excellence was acknowledged by their peers and was considered to be advanced amongst contemporaries. Père Marin Mersenne, after observing some of the mission stations, suggested that they use this structure to corroborate data on magnetics through the Society's colleges throughout the world:

> Let him order that one or another lunar eclipse be observed in these same houses and colleges. If this task were completed and if the authority of the supreme pontiff would lend itself to this task, the result would be that some time under the happy auspices of Urban VIII we would know the magnetic variation of the whole world.[309]

Not only did Mersenne recommend corroboration among the Jesuit missions but his observation that it be done under the authority of the pope suggests that an alignment of data among the

[309] Marin Mersenne, "Treatise on the Magnet," 1639? Marin Mersenne, eds. Armand Beaulieu, Paul Tannery, René Pintard, Bernard Rochot, and Cornélis de Waard. *Correspondance du P. Marin Mersenne: religieux minime*. (Paris: Presses Universitaires de France, 1932), vol. 8, p. 761.

missions would augment the prestige of the Jesuit enterprise as well as the authority of the pope. The organizational structure of the Society and its capacity to be utilized for a number of purposes, both scientific and religious, was acknowledged in Catholic and Protestant quarters. The Jesuits' international missionary efforts received an endorsement from Johannes Kepler, who in a reply to the Jesuit astronomer Albert Curtz, provided a detailed answer and a benediction for the Jesuits' missionary endeavors: "May Jesus Christ, God and Man, and our Lord, to Whom the Eternal Father gave the heathen as an inheritance will that it (the conversion of the Chinese) be fulfilled. Amen."[310]

Missionary science

The scale of Jesuit missionary activity between the first expedition in 1549, nine years after the foundation of the Society, until the latter part of the seventeenth century, is unprecedented. As mentioned in chapter two, established orders such as the Franciscans and Dominicans were present in missionary territories for decades before the Jesuits arrived, but even the most successful of these could not match the Jesuits' rate of expansion, or their innovative approach and method of engagement with a wide variety of cultures, languages and religions. Beginning in

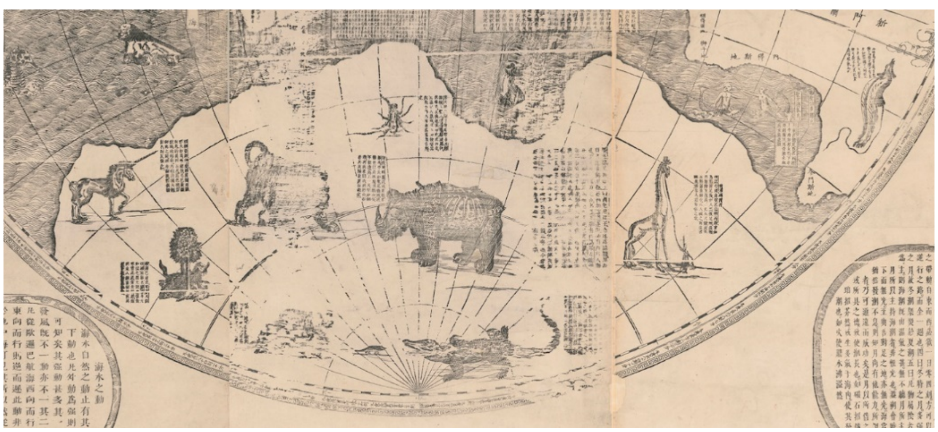

Figure 1: Ferdinand Verbiest, detail of "A Complete Map of the World" (1674); China, Beijing; ink on paper; Geography and Map Division, Library of Congress, Washington DC

[310] Quoted in Pasquale D'Elia, *Galileo in China* (Cambridge, MA: Cambridge University Press, 1960), 33. Quod ratum esse velit Is cui Pater aeternus gentes in haereditatem dedit, Christus Iesus, Deus et homo, Dominusque noster. Amen (December 1627). Curtz was a German born astronomer who wrote under a pseudonym, Lucius Barretus, which was an anagram of Albertus Curtius, the Latinized form of his name.

1549, Francis Xavier and his companions first sailed to Japan and founded the first Jesuit missionary base at Kyushu. Within ten years the Jesuit Bishop de Oviedo and five priests arrived at Ethiopia. Twenty-five years after the community was established, Jesuit missionaries were found in present day Macau, Zimbabwe, North America and the Canary Islands. By the latter part of the sixteenth century, Jesuits missions could be found in Mexico, mainland China, Goa, Pakistan, the Island of Samar in the Philippines, Bangladesh, Nova Scotia, and Brazil. Martinique, Montreal and Guam; Venezuela and the Amazon Basin followed soon after.[311] The Jesuits' international network of scientific knowledge combined with Ignatius' mandate to produce regular correspondence within the Society increased the likelihood that members would receive timely information across the missions. Intentionally or unintentionally, the Jesuit network produced what was probably the first international scientific community, with its origin and inspiration emanating from Rome.

Among the thousands of missionaries who set sail for distant lands in the first two hundred years of the Society, the number of Jesuits who were trained as mathematicians and scientists at Clavius' academy is unknown. Jesuit contributions to the mathematical sciences are well documented, however and they provide a partial view into the impact that Clavius' academy had through training, deployment, technology and texts in the regions in which they served. Jesuit men trained in the academy were beneficiaries of a rigorous program of formation at the mathematics academy and contributed to a steady exchange of information across an international scientific network. Jonathan Wright meticulously recorded Jesuit contributions to the sciences

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[311] The list is a compilation of several sources: The Jesuits: 'God's marines', *The Week* March 23, 2013. Online publication: https://theweek.com/articles/466362/jesuits-gods-marines. Accessed: 3 March 2019. Hobson, John M. (2004). *The Eastern Origins of Western Civilisation*. Cambridge, England: Cambridge University Press, 119, Campbell, Thomas J. (1921). *The Jesuits, 1534–1921: A History of the Society of Jesus from Its Foundation to the Present Time* (New York: The Encyclopedia Press) Retrieved 19 June 2017; Worcester, Thomas. ed. The *Cambridge Companion to the Jesuits* to 1773, (2008).

from their foundation until the 1773 suppression; the exhaustive list includes the development of "pendulum clocks, pantographs, barometers, reflecting telescopes and microscopes . . . magnetism, optics and electricity . . . ; [and had] observed, in some cases before anyone else, the coloured bands on Jupiter's surface, the Andromeda nebula and Saturn's rings. . . . the circulation of the blood (independently of Harvey), the theoretical possibility of flight, the way the moon effected the tides, and the wave-like nature of light."[312] Jesuit mathematicians in seventeenth century China implemented Tycho Brahe's calendrical computations, taught practical and Euclidian geometry, arithmetic, trigonometry,[313] gnomonics, use of the astrolabe, and surveying. In addition, European techniques of instrument-making, including graduating scales, micrometer screws, and eventually the telescope were taught to native populations.[314] Antonio Rubino is credited with bringing the first telescope to the Indian peoples,[315] and as early as 1568, the Jesuits in Peru reported that native craftsmen were using rock crystal to build telescopes whose craftsmanship was said to equal that of their European counterparts.[316]

The Nets of the Mathematicians

Clavius' vision for the "man of the new sciences" and his mathematical missionary strategies were effective and were carried forward by his many devoted students. Among the accounts of the Jesuit missionaries, the expeditions of Matteo Ricci provide an insight into the

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[312] Jonathan Wright, *God's Soldiers: Adventure, Politics, intrigue and Power: A History of the Jesuits.* (London: HarperCollins, 2004), 200.

[313] Catherine Jami, "Western Mathematics in China, Seventeenth Century and Nineteenth Century," in *The Scientific Aspects of European Expansion,* William K. Storey, ed., (Aldershot, GB: Ashgate Pub. Co., 1996), 307.

[314] Joseph Needham, "Chinese Astronomy and the Jesuit Mission: An Encounter of Cultures," in *The Scientific Aspects of European Expansion* William K. Storey, ed., (Aldershot, GB: Ashgate Pub. Co., 1996), 283.

[315] Augustín Udías, *Searching the Heavens and the Earth: The History of Jesuit Observatories* (Dordrecht: Kluwer Academic Publishers, 2003), 55.

[316] Andrés I. Prieto, *Missionary Scientists: Jesuit Science in Spanish South America, 1570-1810* (Nashville: Vanderbilt University Press, 2011), 132.

struggles and successes of the Jesuit priest-mathematicians. Ricci's journals record nearly thirty years of missionary activity in China during the turbulent era of the Ming dynasty (1368–1644). Nicolas Trigault (d. 1628) used Ricci's journals from 1583 to 1610 to chronicle the Jesuits' activity in China. In *De Christiana expeditione apud Sinas suscepta ab Societate Jesu,* Trigault introduces Ricci as a student of Clavius, whom Ricci refers to as the "Prince of Mathematicians."[317] Clavius' convictions echo throughout the work, that mathematics and the new sciences were attractive in themselves and that their truth and clarity had the power to influence those who would otherwise be sceptical of the Jesuits and their message. In his students, Clavius' prophesies were partially fulfilled: Trigault records that Ricci's introduction of the mathematical sciences "amazed the entire philosophical world of China" because of the attraction of their logic. The use of mathematics and the new sciences to draw the Chinese to accept Christianity was not only useful, but necessary:

> In the course of the centuries, God has shown more than one way of drawing men to Him. So it was not to be wondered at that the fishers of men employed their own particular ways of attracting souls into their nets. Whoever may think that ethics, physics and mathematics are not important in the work of the Church, is unacquainted with the taste of the Chinese, who are slow to take a salutary spiritual potion, unless it be seasoned with an intellectual flavouring. It was by means of a knowledge of European science, new to the Chinese, that Father Ricci amazed the entire philosophical world of China; proving the truth of its novelty by sound and logical reasoning.[318]

Trigault uses the metaphor of fishermen who draw souls into Christian nets through mathematics and the new sciences, justifying the adaptation of the Christian message in order to satisfy the intellectual proclivities of the Chinese. The adaptation often proved to be effective: when Ricci arrived in Macao from Lisbon, he brought a mechanical clock to the governor of the

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[317] Ricci, *China in the Sixteenth Century,* 166.
[318] Ibid., 325.

province of Kwangtung. In exchange for the novel gift, the governor gave the Jesuits permission for their first residence. The German John Adam Schall von Bell (d. 1666) became the first Jesuit to receive an appointment from the Manchu Emperor Shun Chih, and served as Director of the Imperial Board of Astronomy in 1644 as a reward for his mathematical and scientific expertise.[319] This position continued to be staffed by Jesuits until 1805.[320]

The approach also proved to be effective in Europe: Christoph Scheiner (d. 1650), a contemporary of Matteo Ricci who spent most of his life between Germany, Austria and Rome, was said to have invented the pantograph before he was ordained in the Society. Scheiner was invited by the Duke of Bavaria to demonstrate his new technology and later to Innsbruck by Archduke Maximilian III, to adjust the Archduke's telescope and answer astronomical questions.[321] Against the backdrop of a culture that was vastly different than that of Ricci, Scheiner used a similar motif of fishing and nets, observing that, "It is evident that mathematics are the nets with which one can catch the magnates and nobles and bring them to God's service."[322] The nets of mathematicians were not only wide enough to include the "entire philosophical world of China" but influential prelates and kings in Europe as well.

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[319] Udías, *Searching the Heavens and the Earth,* 44.

[320] With the exception of three years, this was true almost continuously. Jesuits served as directors even after the 1773 suppression.

[321] William R. Shea, "Scheiner, Christoph," Dictionary of Scientific Biography; "Scheiner, and the Interpretation of Sunspots," Isis, 61 (1970):498-519; "Galileo, Sunspots and Inconstant Heavens," a chapter in his book, Galileo's Intellectual Revolution; Middle Period (1610-1632) (New York: Science History Publications, 1972), pp. 49-74. Stillman Drake, "Sunspots, Sizzi, and Scheiner," Galileo studies: personality, tradition, and revolution (Ann Arbor: University of Michigan Press, 1970), pp. 177-199; Grant McColly, "Christoph Scheiner and the Decline of neo-Aristotelianism," Isis, 32 (1940):63-69; Jean Dietz Moss, "The Significance of the Sunspot Question," a chapter in her book Novelties in the Heavens: Rhetoric and Science in the Copernican Controversy (Chicago: University of Chicago Press, 1993), pp. 97-125.

[322] Quoted in Udías, *Searching the Heavens and the Earth,* 8.

Mathematics as useful and necessary

Beyond the main intellectual attraction of the mathematical sciences, Trigault recounted the usefulness of mathematics in the mission field. Mathematics enabled a clearer perception and judgement among potential converts to the faith. This was evidenced in the case of an unnamed scholar whose views on idol-worshipping were influenced by the discipline of the study of mathematics: "So it happened that not only this particular scholar, but many others like him, were awakened to the absurdity of idol-worshipping by the reasoning demanded in the study of mathematics."[323] The study of mathematics dispelled the darkness afflicting peoples' intellects and prepared the potential convert to receive the truths of faith. Trigault explained how this provided the groundwork for enlightenment that was a prerequisite for conversion:

> Ricci and the missionaries in China acknowledged that the study of mathematics had the capacity to enlightene darkened minds and provide the groundwork for future conversions to the faith and eventually the growth of the Catholic Church in China: all this, namely, what we have recounted relative to a knowledge of science, served as seed for a future harvest, and also as a foundation for the nascent Church in China."[324]

According to Trigault, mathematics and the new sciences provided a way for the Chinese to accept the Catholic faith. Instruction in the mathematical sciences that reflected reason and order increased the Jesuits' credibility and provided the seed for a future harvest of converts.

At the same time, as testimonials recorded the power of mathematics and the new sciences in the mission fields, a parallel theme emerged in the writings of the missionaries that reflects a weakening confidence in the power of mathematics to allure potential converts. The early enthusiasm of fishing and nets is dimmed as Ricci and his companions justify the means of their

[323] Ricci, *China in the Sixteenth Century,* 398.
[324] Ibid., 332.

approach and the desired end of religious conversion. In the passage below, Trigault references Clavius, and states that the use of mathematics and the new sciences (in this instance, cartography) to preach the Gospel is "not at all out of keeping" with traditional methods, such as the study of Scripture or doctrinal catechesis:

> Ricci had had considerable training in mathematics, which he studied for several years at Rome under Father Christopher Clavius, Doctor of Science and Prince of Mathematicians in his day. In answer to the Governor's request, he went to work immediately at this task [of mapping China], *which was not at all out of keeping with his ideas of preaching the Gospel*."[325]

Trigault suggests that not only was the use of mathematics and the new science in keeping with preaching the Gospel; for the Jesuits it was also a means of advancing the Christian message *when traditional approaches failed*. Amidst the innumerable setbacks for the missionaries in China, Ricci and his companions reported that they were more successful in advancing the religious mission of the Society, not through preaching and catechisms, but through the reproduction of maps, astrolabes, clocks, calendars and the prediction of eclipses. Ricci defended this approach by explaining that after years of rejection and hardship, mathematics and the new sciences allowed the Jesuits to introduce Christianity to the Chinese in a way that previously would have never been possible:

> Nothing has impeded our work more than clouds of suspicion. This geographic study, frequently revised and refined and often reprinted, found its way into the courts of the Governor and Viceroy, where it was greatly admired, and finally into the palace of the King, on his own request… This, of course, did not hurt the reputation of the Mission and it helped the Chinese also by gradually building up their desire to know more about the Christian religion.[326]

[325] Ibid., 166. Italics mine.
[326] Ibid., 168.

In a similar passage, Ferdinand Verbiest (d. 1688), a Jesuit from Belgium who served in China during the Qing Dynasty (1644-1912), observed unapologetically that the mathematical sciences were not only a means to an end, but by their attraction "cloaked" holy religion and thereby created passage for the introduction of religion to royal audiences. In *Astronomia Europaea,* he described the passage of Christianity into China in ethereal terms:

> Holy Religion makes her official entry (in China) as a very beautiful queen, leaning on the arms of Astronomy and she easily attracts the looks of all the heathens. What is more, often dressed in a starry robe, she easily obtains access to the rulers and prefects of the provinces.[327]

The attractiveness of holy religion was enhanced *when it relied on science*. By this means it obtained access for the missionary to the host culture.

As the missions in China grew, a second generation of native converts were recruited to join the Jesuits as they advanced their mathematical mission. Again, Trigault qualified his actions by the observation that this is "a work which at first sight might not seem to be wholly in keeping with the purpose of their mission," quickly adding that "once put into practice proved to be quite beneficial."[328] He recounted the zeal of a new convert who pressed for the translation of more recent works so that further study could be undertaken:

> It was during this time that the Fathers undertook a work which at first sight might not seem to be wholly in keeping with the purpose of their mission, but once put into practice proved to be quite beneficial. Doctor Ciu Paul had this one idea in mind: since volumes on faith and morals had already been printed, they should now print something on European sciences, as an introduction to further study, in which novelty should vie with proof. And so, this was done, but nothing pleased the Chinese as much as the volume on the Elements of Euclid. This perhaps was due to the fact that no people esteem mathematics as highly as the Chinese, despite their

[327] Ferdinand Verbiest, *Astronomia Europaea* (1687) Trans. Noël Golvers (Nettetal: Steyler Verlag, 1993), 78.

[328] Ricci, *China in the Sixteenth Century,* 476.

> method of teaching, in which they propose all kinds of propositions but without demonstrations.[329]

In Verbiest's estimation, the Chinese were delighted by the new translations and Doctor Paul's idea was apparently accepted, so that the printing of European science texts would by their weight prevail as worthy of proof. No mention is made of the impact that the "volumes on faith and morals" had on the local population, but Verbiest makes note of the high esteem that the Chinese have for the *Elements* of Euclid.

By the middle of the seventeenth century, Beijing had become a crossroads for the meeting of scientific knowledge, instruments, books, (and informers) of the Qing dynasty. The Jesuits were headquartered at the Church of the Saviour in the northern district of Xicheng, a nexus for the mathematical sciences and new information, and a distribution point for recently translated works from European languages to Chinese and Manchu.[330] The centre of this place of exchange was not the Astronomical Bureau but a church, which may have partially provided a buffer against a suspicious and insecure Xanxi administration. As in Europe, centres where the exchange of scientific knowledge took place had their own unique attraction. Unlike Europe, meeting places that were established outside of the view of the Emperor carried the risk of incurring greater suspicion.

The Jesuits' reputation as mathematicians continued to strengthen in the provinces of Asia. In correspondences to Rome, the missionaries recounted to superiors that their relationship with the Kangxi emperor was not only positive but that the emperor spoke to them with familiarity, gave them valuable gifts of clothing and even had their portraits painted in exchange for their

[329] Ibid., 476.

[330] Noël Govers estimates a library at Beitang included 271 items, mostly in that botany, natural history, and pharmaceuticals, with a publication date before 1618. An estimated 68 books were brought by Trigault and Schreck.

scientific knowledge.[331] Verbiest reports that his efforts to procure instruments for the use of the emperor paid high dividends:

> In four years' time, I completed six astronomical instruments of different types. I spent about 29,000 imperials (a well-known European currency) and composed 16 volumes in Chinese, explaining their entire construction, the theory, their use and also the different ways of (celestial) observation. I also added many other instruments . . . published two maps of the earth . . .[and] offered [it] to the Emperor. Shortly after, he added a new rank (of dignity) and promoted me to mandarin of the second order.[332]

After the emperor publicly acknowledged the work of the Jesuits, other officials in China began to follow suit by visiting the Jesuits in their churches and homes.[333]

Conclusion

In the early years of the Society, mathematical and scientific knowledge was disseminated through Jesuit missionaries whose detailed correspondence brought new information about native curiosities, medicines, and observations of plant and animal life from the Society's periphery to its Roman core. It was, as Ignatius wrote, "a sauce for the taste of a certain curiosity that is not evil."[334] Forty years later, the movement from the periphery to the core had reversed, and scientific knowledge now flowed out from the Roman core of Clavius' mathematics academy to the missions. Clavius' vision for a mathematics program ensured that a regular stream of well-trained priest-mathematicians and scientists would go out from Rome to impart mathematical and

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[331] Florence C. Hsia, *Sojourners in a Strange Land: Jesuits and Their Scientific Missions in Late Imperial* China (Chicago: University of Chicago Press, 2009), 32.

[332] Ferdinand Verbiest, *Mechanica*, in *Ferdinand Verbiest and Jesuit Science in seventeenth century China*, Noël Golvers and Efthymios Nicolaidis, eds., (Athens: Leuven, 2009), 167.

[333] Hsia, *Sojourners in a Strange Land,* 32.

[334] Ignatius to Gaspar Barzaeo, 24 February 1554, *Monumenta Ignatiana. Epistolae et Instructions* (Madrid: Gabrielis Lopez del Horno, 1907), 358.

scientific knowledge to the world. He armed his students with textbooks and created the conditions for mathematics to be exported beyond the halls of the Collegio Romano. As Clavius predicted, the study of mathematics and the new sciences were a source of true and certifiable knowledge. Credible knowledge was useful, powerful and attractive. It provided a way for the Jesuits to certify their mission and message.

In Matteo Ricci's translation of the *Elements* of Euclid, *Jihe Yuanben,* Ricci attests to the dedicated work of Clavius (Master Ding), that made the dissemination of mathematical and scientific knowledge possible:

> During my long journey over sea from the West I have visited many well-known countries. All specialists and experts with whom I conversed, told me spontaneously that, although it is not possible to see into the future, Master Ding [Clavius] by far exceeds previous generations. Master Ding . . . produced two books with additions and further elaborations. Together with the original work, there are altogether fifteen books. For those who study it after him, it is a ford in the river, a bridge, a shelter in case of danger.[335]

Clavius was a mathematician and teacher, but in a more fundamental sense, he was a founder of a movement within an already established tradition. His vision was original and unique; as his mathematical missionaries went forth armed with astrolabes, tables and texts, they served as a "bridge, a shelter in case of danger,"[336] particularly as they entered unfamiliar cultures and at times, complex and dangerous social and political circumstances. Clavius' mathematics gave missionary Jesuits the credibility they needed to transcend cultural, social and confessional barriers.

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[335] Matteo Ricci, preface to the *Jihe Yuanben,* trans. by Peter M. Engelfriet, in *Euclid in China: The Genesis of the First Chinese Translation of Euclid's Elements, Books I – VI* (Leiden: Brill Publishing, 1998), 456.

[336] Ricci, preface to the *Jihe Yuanben,* 456.

At the same time, the exchange of mathematical sciences for traditional methods of evangelization carried with it a burden of justification. The correspondence of the Jesuit missionaries contains repeated claims that religious conversions resulted from the introduction of the mathematical sciences, particularly among the educated classes. Their letters also indicate that the risks associated with attempts to instruct people in the faith led them to insert mathematics and the new sciences as an intermediary that would in theory, spark conversion.

Clavius' premeditated strategy of aligning mathematical sciences with evangelization brought passage and a degree of acceptance amongst the host cultures where the Jesuit missionaries served. It is not always clear whether the missionaries' strategy was active, reactive or a combination of both. What is clear is that their journals and correspondence reflect a diminished confidence in the capacity of mathematics to certify the Jesuits' religious message, and a shift from mathematics as a noble doctrine, in itself brilliant and edifying and a seed for a future harvest to being a shelter in case of danger, a ford in the river or a garment that disguised religion. Their identity as religious men seeking religious ends becomes blurred as the success of the mission begins to be compromised. Chapter seven details the next phase of Clavius' strategy, a move from the certainty of mathematics to the certain truths of faith in Europe and on the missions.

Chapter Seven
Jesuits and the New Science

Because of my world-map, my clocks, spheres and astrolabes and the other things I do and teach, I have gained the reputation of being the greatest mathematician in the world.[337]

- Jesuit Missionary Matteo Ricci

I, for my part, would prefer to see our Friars in China with Crosses around their Necks, rather than with Maps and Clocks in their Hands.[338]

- Dominican Friar Domingo Navarette

By the early part of the seventeenth century, Clavius' priest-mathematicians were mobilized in a mission field of action in Asia, the Americas and throughout Europe. The counter-Reformation missionary strategy outlined by Clavius in the middle of the sixteenth century was grounded in a similar vision of Ignatius Loyola, whose 1553 letter, "To Those Sent on Missions" included a list of "tools" for the Jesuit missionary. Listed among the things that were considered to be useful in converting others to Christianity were sermons, spiritual direction and the teaching of the catechism. Ignatius' exhortations to missionaries included a military metaphor that referred to catechetical instruments as "arms" for the missionary that should be used as prudence dictated:

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[337] Matteo Ricci to General Alvarez, Peking, 12 May 1605, in Tacchi Venturi, *Opere Storiche del P. Matteo Ricci*, (Macerata: Giorgetti, 1913), vol. II, 284-285.

[338] Navarrete's *Controversias*, quoted in J. S. Cummins, ed. *The Travels of Friar Domingo Navarrete* 1618-1686 (Hakluyt Society, 1962), I, 150n.

> [The missionary] should consider the instruments he ought to employ. Besides his example and prayer full of desires, he should consider, for instance, whether to make use of confession, or spiritual exercises and conversations, or catechism teaching, or lectures, or sermons, etc. And he should select those arms (if he cannot make use of all) which are deemed likely to be most effective and which each individual is best able to employ.[339]

Ignatius' affirmation of traditional methods and means was not unique to the Jesuits and would have mirrored the practices of contemporary missionary orders.[340] Sermons, teaching, conversations, lectures and sacred texts were essential tools for those engaged in the work of evangelization. A decade later, the twenty-third session of the Council of Trent (1563) would reiterate that the primary work of the priest, and by extension the missionary, was to preach, offer the sacraments, and care for the ordinary needs of the people:

> [I]t is by divine precept enjoined on all, to whom the cure of souls is committed . . . to offer sacrifice for them; and, by the preaching of the divine word, by the administration of the sacraments, and by the example of all good works, to feed them; to have a fatherly care of the poor and of other distressed persons, and to apply themselves to all other pastoral duties. [341]

The journals and letters of the first generation missionary Francis Xavier reflect adherence to this approach, evidenced in a letter from the missions in which he observes that, "In these pagan lands there is no need for learning beyond what is required for the teaching of prayers, the visiting of

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[339] Ignatius of Loyola: Letters and Instructions, ed. John W. Padberg, et al. St. Louis, Mo.: Institute of Jesuit Sources, 1996, "To Those Sent on Missions," pg. 393–394.

[340] The traditional missionary work of Franciscans, Augustinians and Dominicans in Asia, Africa, South and Latin America and India is well documented. See: Richard Madsen, "Catholic Revival during the Reform Era." The China Quarterly, no. 174 (2003): 468-87. A. Shatzman, *Interlopers: Pirates, Traders, Trappers, Missionaries in the Old World, the New World, and the Creation of the Modern World, 1400–1650: An Interpretive History* (London: Anthem Press, 2013), 109-138. István György Tóth, "Between Islam and Catholicism: Bosnian Franciscan Missionaries in Turkish Hungary, 1584-1716." *The Catholic Historical Review* 89, no. 3 (2003): 409-33.

[341] *The Council of Trent, The Twenty-Third Session. The canons and decrees of the sacred and oecumenical Council of Trent*, J. Waterworth, ed. and trans. (London: Dolman, 1848), 175.

villages, and the baptizing of newborn infants."[342] Within a few years after Francis Xavier set sail for Goa, however, Jesuit missionaries experienced a notable shift in their evangelical emphasis. Francis Xavier's disciple Matteo Ricci wrote that in the Middle Kingdom a different approach was now required: "In order that the appearance of a new religion might not arouse suspicion among the Chinese people, the Fathers did not speak openly about religious matters when they began to appear in public."[343] According to Ricci, the Jesuits in China continued to appear in public but with reserve regarding religious matters. Missionaries were no longer pressed with the question of which arms to employ but whether to use arms at all.

The hardships of the first Jesuit missionaries included challenges common to many missionaries: isolation, limited resources, difficulties with cultural adaptation and illness. The Society of Jesus was distinct from other religious orders in that within a few decades of their arrival, missionaries in Asia and the Americas altered their tactics and exchanged bibles and catechisms for astrolabes and copies of *Euclid.* As confidence shifted from intercessory prayer to medical solutions during the outbreak of a plague in late medieval Europe, the Jesuits began to rely more on the appeal of the mathematical sciences than the explication of doctrine to bring about religious conversion. They found that the use of almanacs, astrolabes and predictions of lunar and solar eclipses secured notoriety and opened doors in China. *This,* rather than catechisms and sermons, enabled them to continue their work as missionaries. In a letter to Father General Alvarez, Ricci notes in one of his appeals for more priest-mathematicians that his knowledge of

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[342] Francis Xavier, S.J., *The Letters and Instructions of Francis Xavier,* M. Joseph Costello, S.J., trans. (St. Louis, MO: The Institute of Jesuit Sources, 1992), 11.

[343] Matteo Ricci, S.J., *China in the Sixteenth Century: The Journals of Matteo Ricci, 1583-1610*, Nicholas Trigault, S.J., ed, Louis J. Gallagher, S.J., trans. (New York: Random House, 1953), 154.

the mathematical sciences (not knowledge of Christ or the catechism) impressed not only the local population, but the whole world:

> These globes, clocks, spheres, astrolabes and so forth, which I have made and the use of which I teach, have gained for me the reputation of being the greatest mathematician in the world. I do not have a single book on astrology but with only the help of certain ephemerides and Portuguese almanacs I sometimes predict eclipses more accurately than they do. And accordingly, I say that, if the mathematician of whom I spoke came here, we could readily translate our tables into Chinese characters and rectify their year. This would give us great face, would open wider the gates of China, and would enable us to live more securely and freely.[344]

Mathematics and the new sciences allowed members of the Society to appear in public and engage in conversation without drawing the suspicion that accompanied discussions about religious matters. According to Ricci and his companions, mathematics bolstered the Jesuits' reputation among the peoples, provided safe passage for the missionaries and secured the conditions for them to carry out their work.

As the Jesuits became more convinced that mathematics and the experimental sciences were critical to their success in China, they regularly petitioned their superiors in Rome to send more mathematicians, texts and scientific instruments to the missions. In 1605, Ricci asked specifically for a good astrologer, something he had evidently requested before:

> I wish exceedingly to beg Your Reverence for something which for many years I have been asking, but without response. And that is that *one of the most useful things which could come from there* [Rome] to this court [of Peking] would be a father or even a brother who is a good astrologer, who could draw up ephemerides.[345]

[344] Matteo Ricci to General Alvarez, Peking, 12 May 1605, in in Tacchi Venturi, *Opere Storiche del P. Matteo Ricci*, (Macerata: Giorgetti, 1913), vol. II, 285.

[345] Pasquale d'Elia, *Galileo in China*, *Relations Through the Roman College between Galileo and the Jesuit Scientist-Missionaries (1610-1640)* (Cambridge: Harvard University, 1960), 6.

Rather than asking for priests and catechisms to be sent for the work of evangelizing the missions the Jesuits sent repeated requests to Europe for well-trained mathematicians and new developments in mathematics and the sciences. According to Ricci, the most useful thing that Rome could send to Asia was a priest mathematician or astrologer. Five years later, the Jesuit Sabatino De Ursis (d. 1620) who held the post of imperial astronomer, wrote to the provincial in Portugal calling for the same:

> When I first came to this mission, Father Matthew Ricci called me to this house at Peking. He wanted me to do mathematical work because he knew that I had some acquaintance with mathematics. He kept me at this for three years (1607-1610) during which I was with him. But since we have no books we can do nothing. The only books we have are Father Clavius' *Gnomica, Sphere and Astrolabe.* So I propose to Your Reverence *that you send us a father who understands mathematics thoroughly*, particularly astrology [astronomy], together with some books on the subject…. ask Father Christopher Grienberger for some beautiful and curious mathematical literature to please these Chinese literati. It will be of great service to the Lord, as I have previously written.[346]

De Ursis' repeated requests for men of the Society who were trained in particular areas of the mathematical sciences resembles Ricci's plea to the Father General, only with a flourish: that new mathematical materials will please the Chinese *literati* and *will be of service to the Lord*. This last line echoes Clavius' sentiment that mathematics liberates the soul and draws the mind to the heavens and ultimately to the Creator of the heavens. De Ursis' observation that "without [mathematical] books we can do nothing" reflects a conviction that it was the credibility of mathematics and the mathematical sciences that allowed them to preach Christianity.

Superiors in Rome were supportive of the missionaries' requests and continued to train and send some of the Society's most talented mathematicians to Asia, as is recorded in a ship's register

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[346] Ibid., 21. Italics mine.

from 1618. Aboard were several notable Jesuits including the Italian James Rho, the Bohemian Wenceslaus Pantaleon Kirwitzer, the Austrian John Alberich, the Swiss John Schreck, and the German John Adam Schall von Bell.[347] Requests continued to come from missionaries in Asia as the Jesuits aligned the successes of their missionary efforts with the availability of good mathematicians and astronomers who were armed with the latest translated texts from Europe. In Japan, new Jesuit missionaries were encouraged to learn mathematics or take a course in mathematics to be more effective in their mathematics ministry. It also provided them with the necessary skill to create mathematical illustrations to enhance the appeal of mathematical texts for their audience:

> In order to get the best possible results from mathematics, it would be advisable to tell the fathers of the other residencies to learn enough mathematics to be able to illustrate in some way the books [of mathematics] that are printed. See to it, also, that the fathers who are to enter the hinterland have a course in mathematics, as was the case this year.[348]

By the late sixteenth century, demand for mathematical missionaries had outstripped supply and superiors in Rome reported that they lacked a sufficient number of trained mathematician-priests to send to the missions.

[347] Eventually Schall was appointed to the Astronomical Bureau and honored as a "Mandarin of the First Order." Florence C. Hsia, *Sojourners in a Strange Land: Jesuits and Their Scientific Missions in Late Imperial China* (Chicago: University of Chicago Press, 2009), 35.

[348] Ibid., 22.

A conscious shift

Within a few decades of their arrival on the missions, Jesuit missionaries were making a conscious shift from Ignatius' initial recommendation that the Jesuits' employ "example and prayer full of desires . . . confession, or spiritual exercises and conversations, or catechism teaching, or lectures, or sermons, etc.,"[349] to win the confidence of their audiences, to the use of mathematical sciences to attract attention, secure credibility and convert others to Christianity. Whether the shift in the Jesuits' approach was the implementation of Clavius' strategy or a reactive response to the challenges they encountered on the mission, their use of mathematics became a source of contention in Europe and in the missionary territories beyond Europe in three central areas: religious, scientific and political.

The mathematical missionaries trained by Clavius to carry out the chosen ministry of drawing others to the truths of faith through the logic and attraction of mathematics were a great ornament to the Society. Their intelligence, creativity and dedication constituted a unique chapter in the story of the Society of Jesus. But the application of mathematical truths as precursors to religious truths (and possible conversion) caused difficulties on the Asian missions. The *literati* in China became wary of Ricci's integration of Christianity and astronomy. In a study he produced called *Tianxue*, or "studies of Heaven" as part of his *First Collection of Celestial Studies*,[350] Ricci proposed that the predictions of celestial phenomena were possible in an ordered universe that was created and guided by a Regulator, the God of the Christians, who governed the universe and all within it.[351] The model was offensive to the Chinese, who saw a physical representation of the

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[349] *Ignatius of Loyola: Letters and Instructions*, ed. John W. Padberg, et al. (St. Louis, Mo.: Institute of Jesuit Sources, 1996), "To Those Sent on Missions," 393–394.

[350] Benjamin A. Elman, *On Their Own Terms: Science in China 1550-1900* (Cambridge, MA: Harvard University Press, 2005), 106.

[351] Matteo Ricci, *The True Lord of Heaven* (Seoul: Kwangdoksa, 1972), 49.

cosmos presided over by the Christian Lord of heaven as a form of heterodoxy.[352] Rather than making a natural transition from the truth of mathematics that "seem not only to persuade but to compel by force"[353] to the truths of the Catholic faith, the Chinese were repulsed by the impertinent placement of a Christian God who ruled over their conception of nature, time and space. Ricci's mathematical strategies did result in some religious conversions but not on the scale or outcome that was anticipated. In 1678, the Confucian scholar Mei Wending observed:

> When Mister Li (Matteo Ricci) during the Wanli period had entered China, he started to promote the study of geometry . . .. However, those books were all dependent on translation . . . it was difficult to find the way, the style is rambling, overflowing with inessentials, and the reader always has difficulty in finishing the work. Moreover, they have adopted Jesus as their religion, which is at variance with what our scholars are used to.[354]

Mei's criticisms of Ricci's work on geometry were mechanical rather than substantive. He is quick to add that the Jesuits' religion was at variance with the local practice of scholars. Was Ricci's exposition of geometry (or the translation) truly substandard or did the Confucian scholar separate himself from the geometrical texts because of Ricci's profession of Christianity? Mei's reserve hinges on Ricci's religious affiliation which brought discredit to his mathematics. For Mei, Ricci's radical personal investment in the Asian culture could not bridge the divide or ease a transition between the mathematical sciences and religious conversion.

Sometimes the Asians were repulsed by Ricci's insertion of Christianity into non-religious studies. At other times, Chinese scholars found his work interesting and Christianity palatable, but

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[352] Ibid., 111.

[353] Christoph Clavius a Emanuele Filiberto di Savoia, Roma 1 febbraio 1574, *Correspondenza* Vol. II-IV, eds. Ugo Baldini e Pier Daniele Napolitani (Pisa: Universita di Pisa, 1992), 15.

[354] Quoted in Peter M. Engelfriet, *Euclid in China: The Genesis of the First Chinese Translations of Euclid's Elements*, Books I-IV (Leiden: Brill Publishing, 1998), 431.

unable to recognize a distinction between the Jesuits' presentation of Christianity and the tenets of Confucianism:

> Your approach of living as if always in the presence of Sangje and of striving to recover your original nature does not seem much different from our Confucian approach. Unlike the Taoists, with their nihilism, and the Buddhists, with their quietism, not once do you threaten morality or deny principle by blocking the path to loyalty and filial piety.[355]

A similar scenario unfolded in Korea: a disciple of the Jesuits, Kim Yuk, a Neo-Confucian scholar and politician, possessed several books on Tychonian astronomy written in the 1630s that were brought by the Jesuits to Korea. The texts did not mention heliocentrism, but Kim accepted the advancements of Western science from the hands of the Jesuits. Kim saw little difference between the teachings of Christianity and the tenets of Buddhism.[356] He supported Catholic teachings to the degree that they reinforced the values of Confucianism but refused to venture further into Catholic theology. When pressed for an explanation, he responded by stating that:

> Your story of the descent of the Lord of Heaven resembles those told of the Buddha's birth. Your doctrine of reward in heaven and retribution in hell- how can that be? If you think you can transform the entire world with such nonsense, you face quite a difficult task.[357]

Amongst Asian scholars, differences also developed in the interpretation of natural systems, which further destabilized the Jesuits' credibility as scientists and mathematicians. The Aristotelian model of immutable heavens used by the missionaries stood in opposition to the Hsüan Yeh doctrine of floating heavenly bodies in an infinite space.[358] The tension around the Chinese

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[355] Quoted in Donald L. Baker, "Jesuit Science through Korean Eyes," *The Journal of Korean Studies*, Vol. 4 (1982-83): 207. Sangje or [Shang-ti] is a Chinese word for "Most High Lord" or "Lord on High."

[356] Ibid., 228.

[357] Ibid., 227.

[358] Joseph Needham, "Chinese Astronomy and the Jesuit Mission: An Encounter of Cultures," in *The Scientific Aspects of European Expansion* William K. Storey, ed. (Aldershot, GB: Ashgate Pub. Co., 1996), 284.

model of equatorial, polar cosmology was (ironically) associated with a cosmology more advanced than Aristotelian crystalline spheres. Their observations led the Asian astronomers to conclude that the heavens aligned more closely with the system developed by Tycho Brahe than that of Aristotle.[359] When the Koreans issued a challenge to Aristotle's immutable concept of the heavens, the Portuguese Jesuit João Rodrigues (d. 1633) responded that the Chinese astronomers had erred in their calculation of the ephemerides.[360]

Jesuit missionaries became increasingly selective in their presentation of the sciences. Towards the end of the seventeenth century, demands for new texts from Europe were coupled with requests that certain materials be excised for presentation. In the 1680s, Verbiest made an appeal from Beijing directly to the Father General requesting the most recent books in medicine and science, asking that potentially offensive material be torn from the text:

> Since I have written this on the introduction of [Western] medicine, I ask our Fatherhood to deign to send us some distinguished medical books, especially of recent date ("modern"), and more precisely printed anatomical diagrams, of large size, and finally if there has been published something new in this science there [in Europe]. Such tables (in which something which could be offensive to the eyes easily could be torn away or emendated) will be able to largely confirm the high respect the Emperor has for European sciences and books.[361]

In Europe, the reputation of Jesuit-scientists suffered setbacks in different quarters. Kepler, Galileo, Brahe and to a degree, Galileo, attested to the integrity of Clavius' work and that of his disciples, but when the Jesuits attempted to gain entry into scientific societies, they were

[359] Baker, "Jesuit Science through Korean Eyes," 222.

[360] Ibid., 213. Joao Rodrigues' reply to Yi Yonghu is in Chinese, in Yamaguchi Masayuki, *Chosen seikyoshi* (Tokyo: Yuzankaku, 1967), 46.

[361] H. Josson & L. Willaert, *Correspondance de Ferdinand Verbiest* (Bruxelles, 1938) 494-495. Quandoquidem haec pro medicina introducenda perscripserim, rogo etiam P(aternitas) V(estra) ut nobis insigniores aliquot libros medicos, praesertim modernos, et nominatim tabulas anatomicas maiori figurâ impressas, ac denique si quid novi hac in scientia in lucem illic editum sit, transmittere dignetur. Eiusmodi tabulae (in quibus, si quid minus decens // oculis occurrerit, facile auferri aut emendari poterit) magnam illam quam Imperator de scientiis librisque Europaeis concepit opinionem plurimum confirmare poterunt. [Trans. M. Looney]

categorically rejected on the basis of affiliation with a doctrinally based community.[362] The *Accademia del Cimento*, the *Academie Royale des Sciences*, and the Royal Society all denied access to the Jesuits because of their doctrinal beliefs and allegiance to the pope. Most scientific societies were chartered with a provision that they remain confessionally unaffiliated or at least neutral. Clavius' alignment of the "noble doctrine" of mathematics and the new sciences with religious conversion distanced Jesuits further from access to scientific societies. The secretary of the Royal Society, Henry Oldenberg, was not alone in his observations that Jesuits could not be relied upon to bring back credible reports of natural history from missionary lands, "considering the principall end of such men's voyages . . . to propagate their faith, and to greaten and enrich themselves by their craft."[363] Christopher Barlow saw Jesuit experimental science as an extension of a papal plot to destroy Protestant theology.[364]

The rapid expansion of Jesuit colleges and universities across Europe's landscape was seen by many in Reformation Europe as a "polluting force" of destructive ideology that was contrived by the Jesuits to bring down Europe's ruling forces and political order.[365] The scientific societies of the sixteenth and seventeenth centuries would have benefited greatly from the skill of notable Jesuits, as well as the knowledge that was disseminated across the international network of Jesuit missionary mathematicians and scientists. The risk of intermingling with doctrinally influenced strategies outweighed the advantages.

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[362] Categorical exemption from scientific societies was common for any organization suspected of being doctrinal in nature.

[363] Quoted in Martha Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century," in *Jesuit Science and the Republic of Letters*, Mordechai Feingold ed. (Cambridge, MA: MIT Press, 2003), 320, fn 101.

[364] Michael J. Gorman, "From "The Eyes of All" to "Usefull Quarries in philosophy and good literature": Consuming Jesuit Science, 1600 – 1665," in The Jesuits: Cultures, Sciences, and the Arts, 1540 – 1773, J. O'Malley, G. Bailey, S. Harris, T. Kennedy eds., (Toronto: University of Toronto Press, 1999), 174.

[365] Gorman, "From 'The Eyes of All,'l" 174.

Some members of scientific societies viewed the Jesuit scientists as an annoyance not because of their religion but because of their habit of currying favour with influential patrons and their reputation for meddling in political affairs. Although members of the Royal Society were unable to survive without a similar dependency on patronage and political connections, they criticized the Society for their demonstrative behaviour in court and equated them with jesters or "jugglers" who employed novel and eye-catching devices to win courtly approval.[366] The Jesuits' penchant for theatre caused John Beales' correspondent Samuel Hartlib to complain that the works of Athanasius Kircher and Christoph Scheiner were an embarrassment, and that they were "right Jesuits to make a great blaze of all things etc. so as to attract more admirers and contributions to their order."[367]

National interests and court intrigue

In addition to religious and scientific misunderstandings, tensions that developed around national interests and political ambitions continually beset the Jesuit missionaries. Ricci's map of the globe that placed China off-centre rather than at the middle of the globe presented more than a cartographic difficulty for the Chinese astronomers. Yi Yonghu wrote to Rodrigues asking him to certify that China was located at the heart of the world, and that the ether that enfolds China in a "two-fold blanket" was the cause of China's greatness and of its ability to produce wise men and the most advanced civilization in the world. Rodrigues responded that any country could occupy the centre on a sphere and that the West produced sages as well, for which he produced the "Heavenly Learning" as an example.[368]

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[366] Ibid., 185.
[367] Ibid., 174. fn 16.
[368] Baker, "Jesuit Science through Korean Eyes," 213.

In Europe, the challenges associated with the Jesuits' work in China and other missionary fields were exacerbated by complex national interests, as Catholic rulers in Europe competed for representation of Jesuit mathematicians and scientists in the Far East. The competition among European powers initially enhanced the notoriety of the Society. In France, for example, the Jesuits were known as "the King's Mathematicians."[369] But when the French Jesuits entered China as delegates for the king of France, they defied a mandate established by the king of Portugal that claimed primacy in the China missions. The French Jesuits maintained that they were acting as "correspondents" for the Royal Academy in Ningbo.[370] The strain between French and Portuguese men on the mission mirrored that of the two countries who vied to protect their national interests, particularly in colonial territories.

In the absence of qualified mathematicians to meet the demands of court, the Jesuits, according to the Polish, Jesuit-educated missionary Feodosii Smorzhevskii, credentialed themselves as specialists where there were no qualified mathematicians or astronomers. Smorzhevskii opined in his diary that every Jesuit was some sort of "specialist…even if he is not one."[371] These "specialists" soon came under suspicion as working under disguise to gain access to imperial power. Smorzhevskii also complained that the Jesuits in China participated in court intrigues and placed obstacles designed to limit the access to court of other religious orders.[372]

Other forms of suspicion arose as Jesuits were accused of court manipulation, as seen during the term of the first Jesuit appointed to the Bureau of Astronomy in Peking, John Adam Schall von Bell. When the Dalai Lama arrived for a visit to Beijing in 1652, Schall supplied the

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[369] Catherine Jami, "Western Mathematics in China, Seventeenth Century and Nineteenth Century" in *The Scientific Aspects of European Expansion,* William K Storey, ed., (Aldershot, GB: Ashgate Pub. Co. 1996), 307.

[370] Engelfriet, *Euclid in China,* 435.

[371] Cited in Barbara Widenor-Maggs, "The Jesuits in China": Views of an Eighteenth-Century Russian Observer," *Eighteenth-Century Studies* 8 (Winter, 1974-1975): 142.

[372] Ibid., 142.

court secretaries with bad omens to temper the event and the prestige of their guest. He alerted the court that sunspots had appeared, signaling that the Dalai Lama was obscuring the radiance of the Emperor, a calculated move to downplay the visit of the Dalai Lama to the court.[373]

The Jesuits used gifts to engender the goodwill and confidence of influential members of court. Sometimes the calculated gesture backfired, as in the case of Rodrigues who met with a Korean diplomat in the city of Tengchow in 1631. Rodrigues presented Chöng Tu with books on astronomy and geography, world maps, a telescope, a pair of guns, a sundial and an automatic clock. Apparently pleased by the generosity of the Jesuit, Chöng reported his admiration for the Jesuit's technical skills and calendrical calculations and found Rodrigues to be possessed of "a noble spirit and graceful appearance. He was like one of the immortals."[374] Rather than using the telescope for astronomical purposes, however, Chöng and his colleagues repurposed the telescope for espionage, and were delighted that the telescope allowed them to "clearly observe even the smallest details of an enemy camp. . . ."[375] In another instance, the Jesuit's gift of an automatic clock was used as a toy that spurred universal laughter.[376]

In Vietnam, a graver scenario unfolded as missionaries met with initial success, followed soon after by the unfortunate consequences of imperial suspicion. Before the Jesuit Alexander de Rhodes left Rome for Vietnam in 1619, he dedicated time to learning all he could about mathematics and the new sciences, incorporating them into his religious study and dedicating a large part of his initial formation to what he referred to as his "principal occupation."[377] When he arrived in Vietnam, De Rhodes took advantage of the fact that the new sciences had not yet arrived.

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373 Elman, *On Their Own Terms,* 138.
374 Baker, "Jesuit Science through Korean Eyes," 220.
375 Ibid., 220.
376 Ibid., 220.
377 Widenor-Maggs, "The Jesuits in China,"447.

What worked initially for Ricci in China also worked for de Rhodes in Vietnam: using an exchange of gifts for privileges in the court of the emperor, de Rhodes secured his credibility with Trinh Trang, the viceroy of the Tonkin Empire. An automated clock delighted the viceroy and created awe and wonder among all those assembled. But as the novelty of the mechanical clock waned and new waves of suspicion began to erode the emperor's decision to grant a two-year residency for the Jesuit and his companions, they were pressed to produce something new. An astronomical prediction that was unknown to the Vietnamese ruler and his court allowed de Rhodes to further his residency. Using a previously charted lunar eclipse, de Rhodes "predicted" the eclipse and appeased the wariness of the ruling powers in the Nghean province. In a burst of enthusiasm, the governor exclaimed:

> If these people know how to predict with so much assurance and accuracy the secrets of heaven and the stars—which are unknown to us and surpass our capacities, *shouldn't we believe that they are correct about the knowledge of the Law of the Lord of Heaven and of the earth, and of the truths that they preach to us . . .*?[378]

Not only were mathematics and the new sciences useful in predicting celestial events and solving important problems for the viceroy or governor, they could reinforce the certainty of eternal truths (as Clavius predicted). But de Rhodes and his companions soon suffered a fate similar to Ricci in China. A strategy that was accepted with initial enthusiasm weakened and soon fell under imperial suspicion. De Rhodes and his followers were rejected by the viceroy, sent into exile and de Rhodes eventually witnessed the decapitation of his assistant, André.[379] By 1706, the Kangxi emperor in China likewise believed that the Jesuits were not mathematicians or astrologers but agents of

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[378] Alexander de Rhodes, *Histoire du Royaume de Tunquin et des grands progrèz que la prédication de l'évangile y a faits en la conversion des Infidelles. Depuis l'année 1627 jusques à l'année 1646*, Henri Albi, trans. (Lyon : Cramoisy 1651), 195-96. [italics mine]

[379] Widenor-Maggs, "The Jesuits in China," 448.

Rome. The emperor's son, the eldest prince, thought that the Jesuits were Spanish or Portuguese spies who were secretly plotting an invasion of China. By 1717, the emperor had altogether prohibited the presence of missionaries in China.[380]

As the tide began to shift on the missions, the early optimism of the Jesuit missionaries and the remarkable successes of the early years of Clavius' program for evangelization through mathematics began to wane. By the beginning of the eighteenth century, mathematical and scientific content remained in textbooks but all references to Christianity were removed. The Jesuits' reliability in both secular and sacred matters was viewed with increased suspicion as the atmosphere grew more tense for the missionaries. After forty years in China, a paralyzed and speechless Schall, the first Jesuit to receive an appointment to the Bureau of Astronomy in Peking, was condemned to being hacked to pieces.[381] In some cases, an association with a particular dynasty during years of transition could prove to be fatal, as *literati* and political elites remained precariously poised at the top of the social hierarchy, with imperial astronomers and calendrical specialists in the middle, who were subject to the vicissitudes of rule.[382]

Reaction from Rome

Amongst Jesuit superiors and members of the Society in Rome disagreement emerged about the appropriateness of the missionaries' tactics. Some objected to the honoraria that were

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[380] Benjamin A. Elman, *A Cultural History of Modern Science in China* (Cambridge, MA: Harvard University Press, 2006), 34.

[381] Thomas J. Campbell, S.J., *The Jesuits:1534-1921,* Vol. 1. (New York: The Encyclopedia Press, 1921), 377.

[382] Benjamin A. Elman, "Some Comparative Issues in the World History of Science and Technology: Jesuit Learning in Late Imperial China," *Beyond Text: New Perspectives on Material Culture Studies* (Taipei: Qing hua xue bao, 2011), 158.

conferred upon the Jesuit missionaries by imperial courts which included key positions in local governments. Ferdinand Verbiest was criticized by members of the Society for his appointment to the Bureau of Astronomy and Ricci's activities were scrutinized in a letter from Nicolò Longobardo in 1615, where he objected to Ricci's strategies, adding that Ricci was a "timid, fussy man . . . trying with his Mathematical games to win over the friendship of the Mandarins."[383] The place of mathematics and the new sciences in the pedagogy of the Society was already a source of division. The new approach of replacing the explication of religious doctrine with seemingly more accessible, reliable content exacerbated the tension.

Not all challenges on the missions were due to the strategies of the missionary Jesuits. The College of Macau, for example, reported in 1619 that their residences were packed with exiled Jesuits from Japan whom they described as "distrustful and despondent priests."[384] Superiors tried to resolve the situation by creating a teaching program in the Vice-Province in the Ming (1368-1644) Empire.[385] In other places, the presence of the Society was rejected for reasons that were not necessarily scientific or religious but pedagogical. The Jesuits distinguished themselves from the predominant educational culture, which created suspicion among secular clergy and religious orders whose schools already existed in the province. Jesuit pedagogy and method were met with resistance in towns where the existing educational systems conflicted with the Jesuit approach. Local inhabitants were not always convinced of the Jesuits' methods, and students resented the high expectations set by Jesuit teachers. Ecclesiastical officials and members of religious orders were sometimes less than hospitable in accepting Jesuits into their dioceses. The Society had great

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[383] Ibid., 332.

[384] Liam Brockey, *Journey to the East: the Jesuit Mission to China, 1579-1724* (Cambridge, MA: Belknap Press of Harvard University Press, 2007), 251.

[385] Ibid., 251.

difficulty establishing schools in Paris and Lyon.[386] After issuing a protracted list of unorthodox behaviours associated with the Jesuits, the theology faculty at the University of Paris (alma mater of Ignatius and many of the early Jesuits) concluded that they were a menace to Church and state: "Therefore . . . this Society seems to endanger the matter of faith, to disturb the peace of the Church, to overthrow the monastic and religious life, and to result in more pulling down than in building up."[387] In Bergamo, the Somaschans, a religious society founded contemporaneously with the Jesuits and comparable in their apostolic mission were warmly welcomed as teachers and priests by the local inhabitants in 1632. They were invited over the Jesuits to conduct the school because they were "considered to be more frugal and more familiar with the local situation than the Jesuits had been."[388]

But by the middle of the seventeenth century, difficulties with the scientific missionary tactics were significant enough to warrant a visit from Rome. In 1658, Bishops Francois Pallu and Pierre Lambert de la Motte arrived on the missions, having been sent by the papal Congregation for the Propagation of the Faith. The result was a document, *Instructiones ad munera apostolica rite obeunda* that stated that missionaries ought to be of good repute to enable their message to be heard, and that those who cultivated the sciences and the arts to be regarded as "ingenious and learned" risked the misunderstanding of being considered "cunning" men.[389] Already at the time

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[386] Christopher Carlsmith, "Struggling toward Success: Jesuit Education in Italy, 1540- 1600," *History of Education Quarterly* 42 (Summer, 2002), 245.

[387] Juan Polanco, from the *Monumenta Historica Societatis Iesu* in *Jesuit Writings of the Early Modern Period, 1540 – 1640*, John Patrick Donnely, S.J., trans., ed., (Hackett Publishing Company, Indianapolis, 2006), 244.

[388] Quoted in Carlsmith, "Struggling toward Success," 245.

[389] Francois Pallu and Lambert de la Motte, *Instructiones ad munera apostolica rite obeunda perutiles missionibus Chinae, Tunchini, Cochinchinae, atque Siami accommodatae / a missionarijs S. Congregationis de Propaganda Fide*, (Romae: per Zachariam Dominicum Acsamitek a kronenfeld Boemum Pragensem, linguarum orientalium typographum, 1669), Necnon etiam contingit aliquando, ut quum ingeniosi, doctique his artibus Missionarii velint habere, quo in Religione docenda sibi fidem et auctoriatatem concilient, contrario eventu ipsis tamquam callidioribus viris vel diffidatur, vel penitus fides negetur. [Trans. M. Looney]

of Pallu and la Motte's visit, Ricci's religious writings had been on the Chinese "Index" for nearly thirty five years.

Conclusion

The circumstances under which the Society was approved as a religious community amidst the challenges of the Catholic Reformation and the Scientific Revolution allowed them to venture farther than their contemporaries in evangelizing peoples in Europe and on the mission territories. As second-generation Jesuits allied themselves with mathematics and the new sciences, they were followed with suspicion because of their unorthodox methods of evangelization. It was a sharp contrast to the bright confidence of the early Jesuits and the prediction of Clavius that men from the Society would be distributed to "various nations and kingdoms like sparkling gems," who would incite fear in their enemies and draw "young people to us from all parts of the world, to the great honour of the Society."[390] Clavius' vision did materialize, but not in the manner, nor with the results he imagined.

According to the diaries of the missionary Jesuits, the peoples of Asia were eager to acquire the mathematical and scientific knowledge that came from the West. The mathematical sciences provided a bridge and a shelter for the Jesuits in unfamiliar territory and secured greater access to influential audiences. Jesuit priest-mathematicians presented European mathematics and sciences at court and were rewarded in turn with gifts, honours and positions at court. Mathematics and the new sciences enabled the Jesuits to be received and trusted because of the certifiable and demonstrable knowledge of the mathematical sciences. However, the missionaries' alignment of the certainty of mathematics and the new sciences with the truths of religious faith produced the

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[390] Quoted in Gorman, "From "The Eyes of All," 113.

opposite of what was intended: the means were retained while the end the Jesuits hoped to promote – the faith – was discarded. Clavius' prediction that mathematics had the capacity to foster truth and draw others to itself by the beauty of its clarity was in part, true. But his observation that credible authority would be gained among the multitudes of those living far away, and that those who were distanced from the Catholic belief would be called back did not materialize.[391] In some instances, it resulted in fostering repulsion towards the Jesuits and rejection of Christianity. In China, on the other hand, after years of mathematical-evangelical instruction, the Jesuits were no longer known as Catholics or priests but were nicknamed "the mathematicians."[392] Ricci's once eager Christian disciples returned to the practice of Confucianism[393] but kept the books, astrolabes and maps. Eventually, the Chinese disregarded the Christian teachings altogether and by 1623, Ricci's religious writings were on the "Chinese Index" of prohibited books.[394] The Korean scholar Yi Ik, like many of his contemporaries, appropriated Aristotelian cosmology but rejected its religious elements.[395] In Japan, Ricci's maps were integrated into the Japanese culture and received as reliable after the references to Christianity were removed and native Japanese forms of cartography were inserted.[396]

The Jesuits' crisis of credibility in Asia was not a common rejection often associated with ill-equipped missionaries who lacked sufficient preparation or were ill-attuned to the culture. The

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[391] See: Christopher Clavius, *Discursus P. Christophori Clavii de modo et via qua Societas ad maiorem Dei honorem et animarum profectum augere hominum de se opinionem, omnemque haereticorum in literis aestimationem, qua illi multum nituntur, convellere brevissime et facillime posit*, in *Monumenta paedagogica Societatis Iesu,* Lukacs, Ladislaus, S.J., ed. [(Romae : Apud Monumenta Historica Soc. Iesu, 1965 (1992)], VII, 119.

[392] Widenor-Maggs, "The Jesuits in China," 447.

[393] Catherine Jami, "Western Mathematics in China, Seventeenth Century and Nineteenth Century" in *The Scientific Aspects of European Expansion*, William K Storey, ed., (Aldershot, GB: Ashgate Pub. Co. 1996), 307.

[394] Helen Wallis, "The Influence of Father Ricci on Far Eastern Cartography," in *The Scientific Aspects of European Expansion,* William K. Storey, ed. (Aldershot, GB: Ashgate Pub. Co., 1996), 4.

[395] Baker, "Jesuit Science through Korean Eyes," 215.

[396] Wallis, "The Influence of Father Ricci," 45.

opposite could be argued: that the Jesuits were *more* adept at assimilating into host cultures than other religious orders and invested themselves more intentionally into their host cultures than any of their contemporaries. They were armed with the resources of an order of well-formed scholars who were engaged in an international exchange of knowledge and practical experience. The introduction of the mathematical sciences to the missions by men who appeared not as priests but mathematicians, destabilized the message which decades of missionaries had worked to impart to their host audiences.

Matteo Ricci was born the year Francis Xavier died. Ricci attempted to follow in the footsteps of Francis Xavier, who though never having reached the China shores, his "shadow loomed over the China enterprise for over a century,"[397] in India and Japan. In a fundamental way, however, Matteo Ricci was not Francis Xavier. The miracles and divine manifestations attributed to Francis Xavier were not bequeathed to Ricci and the men of his generation. Under the inspiration of Clavius and in the face of resistance, they relinquished the traditional strategies of their predecessors in order to remove the "clouds of suspicion"[398] and "open wider the gates of China."[399] Clavius, emboldened by his success in resolving and defending the reform of the calendar, built a mathematics academy and credentialed his students for a vocation within a vocation as priest-mathematicians. But the successes of the first generation of Jesuit missionaries were peculiar to their age; the missionary efforts of Clavius and his protegees that were designed to draw others to the Catholic faith through mathematics and the new sciences resulted in the dissemination of mathematical sciences, but also a lingering suspicion about the credibility of the Catholic faith brought forth from Europe by the Jesuit missionaries.

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[397] Campbell, *The Jesuits:1534-1921,* 244.
[398] Ricci, *China in the Sixteenth Century,* 168.
[399] Venturi, *Opere Storiche,* 285.

More than four centuries later, the efforts of Clavius and his missionary mathematicians are still evidenced in China. The artefacts that remain speak more of mathematics and the sciences than of the Jesuits or even of Christianity. In Peking, where the old walls attest to the Society's influence in the Imperial court, there are no cultural remnants of the Catholic faith. Instead, atop an old bastion along the city wall, the computational instruments of Ferdinand Verbiest, Imperial astronomer and mathematician, still lie.

Chapter Eight
Authority, Identity and Crisis

We are accused of getting too mixed up in secular affairs; of having too much to do with the people of the world and too many occupations dissipating us; of being too free in our doctrine and too fond of novelty, self-interested and avaricious, jealous of our honour and our public reputations…[400]

-- Father General Claudio Aquaviva to the Society of Jesus

Throughout much of their history, members of the Society found themselves engaged in a battle on two fronts. The first was an internal struggle for consensus about a unified, coherent philosophical and theological core, a consensus which proved unattainable. Thomistic theology, which comprised the core of Jesuit pedagogy, relied upon Aristotelian structures and terminology for its framework. From the Society's foundation, superiors recognized the dependence of Scholastic theology upon the principles of the ancient Greek philosophers. The primacy of the Ancients and Scholastics in the Society was repeatedly reinforced by superiors but often contested among members. As the mathematical sciences evolved and separated themselves from the teachings of the Ancients, the task of attaining a unified philosophical approach in the Society became increasingly challenging and complex.

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[400] Claudio Aquaviva to the members of the Society, *Epistulae Praepositorum Generalium*, vol. 1 (Brussels, 1909), 164.

In addition to a lack of uniformity in the philosophical and theological disciplines, the men of the Society were unable to reach consensus with regard to the place of mathematics and the new sciences in relation to natural philosophy. The Jesuits were not alone in this; the broader Italian academic community of the sixteenth century was divided on the subject. Some adopted the stance that pure mathematics was not *scientia* in the Aristotelian sense, as mathematics treated quantities that were by definition, removed from causality and physical reality. Some of Clavius' contemporaries agreed that mathematics supported the other sciences, but beyond that did nothing more than provide a framework for logic and the quantification of substances, ultimately viewed it as an abstraction with an artificial relation to the physical world.[401] Natural philosophers also maintained that Euclidian geometry consisted of a series of arbitrary constructions which lacked necessary causal connections and disqualified it according to the criteria of natural philosophy.[402] Some natural philosophers at the Collegio Romano, such as Jesuits Benedict Pereira and Francesco Piccolomini, agreed with Clavius that mathematics possessed its own integrity as a discipline, but because it lacked a fundamental relation to the natural world (and therefore, natural science), they thought that mathematics lacked *a priori* the qualifications to be a free standing, independent discipline.[403] Others took a more extreme view that the independent study of mathematics was not only inadvisable but perilous. The Spanish Jesuit Enrique Enriquez, took his list of objections to the Spanish Inquisition, complaining that the study of mathematics as an independent discipline undermined the tradition of the Jesuits' Aristotelian-Thomist pedagogical foundation.[404] Ludovico Carbone, (d. 1597) a contemporary of Clavius at the Collegio Germanico rigorously opposed the

[401] Rivka Feldhay, *Galileo and the Church: Political Inquisition or Critical Dialogue?* (Cambridge: Cambridge University Press, 1999), 110.

[402] James Lattis, *Between Copernicus and Galileo* (Chicago: University of Chicago Press, 1994), 34.

[403] Ibid., 36.

[404] Feldhay, *Galileo and the Church,* 222.

advancement of mathematics in the Society and published a detailed account of eleven doubts regarding the type of abstraction associated with mathematics and its lack of connection with substance. Benedict Periera and Francesco Piccolomini (d. 1651), later a Father General in the Society, supported Carbone's work because it was in keeping with the contemporary notion of natural philosophy and cohered well with scholastic doctrine and the traditional classification of the sciences.[405]

Clavius' countered his critics by taking a utilitarian stance in support of the value of mathematics as an independent discipline in the Society. Mathematics, he argued, supported the evangelizing work of the Society because it was true, useful, capable of clarifying error and misunderstanding, attractive to men who were influential and important in building the credibility of the Society. The work of mathematicians enabled theologians and philosophers to execute their studies with greater precision and clarity, and the mathematical sciences were indispensable for the proper understanding of the natural sciences. When confronted by his contemporaries about the proper classification of mathematics in relation to natural philosophy, Clavius placed an emphasis instead on what mathematics could *do*. As Archimedes provided a solution for the King of Syracuse, knowledge of mathematics and its applications moved men beyond speculation to real solutions. Mathematics was useful and necessary in order to build and preserve society; it assisted nobility such as the Duke of Savoy in building armaments and fortifying towns. Mathematics had the capacity to reconcile uncertain matters through quantification. It fostered truth, refuted error and was useful in countering the claims of heretics. According to Clavius, mathematics as a weapon was useful against enemies, being one of the "remaining [arts and

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[405] Roger Ariew, "Christopher Clavius and the Classification of Sciences," *Synthese*, Vol. 83, No. 2, (May, 1990): 298.

sciences], such as mathematics … so that the Society yields to no heretics, but yields by necessity to many Catholics, among whom are found these individuals more eminent that then individuals of the Society."[406] In *Modus quo disciplinae* (1582), Clavius urged members of the Society to set aside disagreement about the place of mathematics in the Society and to simply encourage students to pursue its study:

> It would also be useful if, in private conversation, teachers were to encourage students to learn these [mathematical] sciences, impressing on them their necessity and not, on the contrary, leading them away from the study of these [sciences], as many have done in previous years. In this way, there will be removed every disagreement that is observed by externs to exist among Ours, when a teaching such as this is heard in schools.[407]

Clavius' admonished his colleagues to refrain from disagreements about mathematical sciences and to concede its advantages, so that the pursuit of mathematics could proceed on its own merit. He adds an observation that tension and division amongst members of the Society causes confusion amongst the students in the schools. In the same document, Clavius makes an appeal to the Society's philosophers to respect the integrity of the mathematical disciplines and to cease sowing confusion amongst students. Referring to the inherent value of mathematics, Clavius adds a weighty phrase, "authority of mathematical disciplines" to make his point:

> It will also contribute much to this if the teachers of philosophy abstained from those questions which do not help in the understanding of natural things and very much detract from the authority of mathematical disciplines in the eyes of the students, such as those in which they teach that the mathematical sciences are not sciences, do not have demonstrations, abstract from the being and the good, etc.; for experience teaches that these questions are a great hindrance to pupils and of no service to them; especially since teachers

[406] Christopher Clavius, *Correspondenza*, Vol. II-IV, 1570-1601, eds. Ugo Baldini and Pier Napolitani (Pisa: University of Pisa, 1992), 117.

[407] Christopher Clavius, *Modus quo disciplinae mathematicae in scholis Societatis possent promoveri,* Document 34, trans. Dennis Smolarski, S.J., in "Historical Documents, Part II: Two Documents on Mathematics," *Science in Context* 15 (2002): 467. "Ours" is an expression used by the Jesuits in reference to the community.

> can hardly teach them without bringing these sciences into ridicule (which I do not know just by hearsay).[408]

Clavius was still admonishing the natural philosophers nearly ten years later in the 1591 draft of the *Ratio* under the section entitled, "Rules for the Provincial Superior: On Mathematics", and closes his treatise with an *argumentum ad hominem*:

> Let those who preside take utmost care, that the professors of philosophy not disparage the dignity of mathematics while teaching or at other times, and not rebut their [mathematical] sententia, as about epicycles; for it often happens, that the less one knows about such things, the more he disparages them.[409]

Many of Clavius' contemporaries remained unconvinced. In turn, Clavius charged that these same were responsible for the "devaluation of mathematics" within the Society and were the same natural philosophers who, because of a lack of mathematical knowledge, made serious errors and bad syllogisms, and even had these published.[410] During his tenure, Clavius moved between being an untiring promoter of the beauty and brilliance of the mathematical sciences to defending himself against the natural philosophers whose erroneous assessment of mathematics had, in his estimation, led them to ill-informed ideas about mathematics. The nature and place of mathematics

[408] Cited from English Translation of *Modus quo disciplinae* in Wallace, Galileo and His Sources, 2014, 137. Tacent, professores hac re apud auditores magnam sibi auctoritatem conciliaturos, cum intelligerent eos loca Aristotelis et aliorum philosphorum, quae ad mathematicas disciplinas pertinent, pro dignitate tractare. Ex quo etiam fiet, ut discipuli magis intelligent harum scientiarum necessitate. Ad hoc etiam multum conferet, si praeceptores philosophiae ab illis quaestionibus abstineant, quae parum iuvant ad res naturales intelligendas, et plurimum auctoritatis disciplinis mathematicis apud auditors detrahunt; quales sunt illae, in quibus docent, scientias mathematicas non esse scientias, non habere demonstrationes, abstrahere ab ente et bono etc. Nam experientia docet, multum haec obese auditoribus, prodesse autem nihil; praesertim, quia praeceptores ea vix (quod non semel ex relatione aliorum cognitum est) sine derisione harum scientiarum docere posunt. 1591 *Ratio Studiorum*, "Rules for the Provincial Superior: On Mathematics", n. 44 [*Monumenta* 14-II, p. 117]. *Modus quo disciplinae mathematicae in scholis Societatis possent promoveri.*

[409] Quoted in Dennis Smolarski, "The Jesuit Ratio Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities," *Science in Context* 15 (2002): 449.

[410] Quoted in Cosentino, Giuseppe. "Mathematics in the Jesuit Ratio Studiorum," in *Church, Culture, & Curriculum: Theology and Mathematics in the Jesuit Ratio Studiorum*, Lukacs and Cosentino, eds. (Philadelphia: Saint Joseph's University Press, 1999), 62.

as a discipline continued to be debated for generations after Clavius, but during his lifetime he remained steadfast in maintaining that the usefulness of mathematics was sufficient evidence to secure its status among the other disciplines in the *Ratio*.[411] In the seventeenth century, the tension had not yet subsided as evidenced by an observation from the Italian Jesuit Cardinal Pietro Sforza Pallavicino in *Vindicationes Societatis Jesu* (1649) that the Jesuit natural philosophers, not mathematicians, were responsible for the Society's success and contributed to the fame, esteem, and respect which the Society commanded among learned men.[412]

Implementing the 1599 *Ratio*

After more than forty years of drafts, discussions and revisions, the definitive version of the *Ratio Studiorum* was promulgated on 8 January 1599. The introductory letter by Father James Dominic, secretary for the committee, stated optimistically that the committee hoped that the document would be well received among members of the community, and exhorted superiors to wholeheartedly embrace the project as it was being set forth:

> Finally, the task was completed, and we have good reason to hope that the final version will meet with the approval of all . . . I am quite convinced that if the members of our Society realize how much this project means to our Father General, they will comply cheerfully with his wishes. Since responsibility for the success of this Ratio Studiorum lies squarely on the shoulders of superiors, Father General urges them to make every effort to secure from their subjects ready and complete dedication to this program which breathes the spirit of our Constitutions and promises to be of untold advantage to our students.[413]

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[411] Quoted in Cosentino, "Mathematics in the Jesuit Ratio Studiorum," 62. "Without mathematics, effects that depend on their conjunctions, oppositions, and other distances between themselves, infinite division of continuous quantity, tidal ebb and flow, winds, comets, rainbows, halos and other meteorological phenomena, or rations of motions, qualities, actions, passions, and reactions, that the calculators described."

[412] Martha Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century," in *Jesuit Science and the Republic of Letters*, Mordechai Feingold ed. (Cambridge, MA: MIT Press, 2003), 308.

[413] *The Jesuit Ratio Studiorum of 1599*, Allan P Farrell S.J., Trans., (Washington, DC: Conference of Major Superiors of Jesuits, 1970), xiii.

The 1599 *Ratio* emphasized a traditional pedagogy of ancient and scholastic sources, sending a message to members of the Society that the intellectual patrimony of the Society was to be grounded in Aristotle and Thomas Aquinas. Professors of philosophy were instructed to hold Aristotle in high esteem and to persuade their students to do the same:

> He [the professor of philosophy] should make it his chief aim to interpret well the text of Aristotle and be as painstaking in this interpretation as in discussing the subject matter itself. He should likewise convince his students that their philosophy will be weak and wanting if they do not value highly this study of the texts."[414]

Philosophy teachers were expected to be "painstaking" in their interpretation of Aristotle's texts. Those whose views strayed too far from the approved corpus of readings were to be removed from the classroom:

> Teachers of philosophy who show themselves too inclined toward new doctrines or too liberal in their views should certainly be removed from teaching.[415]

A similar directive is contained in the 1599 version for prefects of study, who were to ensure that Ancient and Scholastic sources were amongst the students' books:

> He [the prefect] shall not give permission to students of theology and philosophy to have books of any and every nature. . . The theologians should have the *Summa* of St. Thomas, the philosopher Aristotle, and addition some selected commentary which they may consult in their private study.[416]

[414] "Rules of the Professor of Philosophy", *The Jesuit Ratio Studiorum of 1599,* 43, #12.
[415] "Rules of the Provincial", Ibid., 4, #16.
[416] "Rules for the Prefect of Studies", Ibid., 24, #30.

Equivalent instructions for theology professors are scattered throughout the 1599 *Ratio*, accompanied by consequences for those who did not uphold the teachings of Aquinas. The provincial was directed to remove any professor who was not inclined toward Scholastic theology:

> The provincial is to be especially careful that no one be appointed to teach theology who is not well disposed to the teaching of St. Thomas. Those who do not approve of his doctrine or take little interest in it, should not be allowed to teach theology.[417]

Finally, the text invoked local and ecclesial authority to underscore the gravity of adhering to St. Thomas and the Scholastics:

> By all means, Ours should consider St. Thomas as their special teacher, and they should be obliged to follow him in Scholastic theology, first, because our Constitutions commend this to us in § 1 of chapter 14 of part 4 and the supreme pontiff, Clement VIII has indicated that he desires it; and second, because letter K of chapter 1 of part 8 of the *Constitutions* admonishes us to select the doctrine of one writer, and at this time there can hardly be a doctrine more solid and safe. St. Thomas is deservedly regarded by all as the prince of theologians.[418]

The frequency with which directives appear throughout the final 1599 version of the *Ratio* indicates that adherence to orthodoxy and traditional sources was not an option but an obligation for members of the Society. Several degrees of authority are invoked, including the constitutions of the Society (twice) and the express desire of a pontiff (once), making it clear that the official position of the Society was to adhere to a doctrine that is "solid and safe."

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[417] "Rules of the Provincial", Ibid., xiv, Sec. 9, #2.

[418] Quoted in Louis Caruana, from the *Ratio Studiorum,* "The Jesuits and the Quiet Side of the Scientific Revolution," in *The Jesuits*, Thomas Worcester, ed., (Cambridge, UK: Cambridge University Press, 2008), 256.

Reduction of Mathematics in the *Ratio*

Despite Clavius' efforts, the final 1599 version of the *Ratio* only minimally addressed the place of mathematics and the new sciences in the Society's pedagogical plan.[419] The one-hundred and eleven-page document mentions Aristotle fourteen times, Thomas Aquinas twenty times and Cicero thirty-two times. Euclid and Pythagoras are mentioned once, and Archimedes, Ptolemy and Copernicus receive no mention. The sciences are classified beneath the Aristotelian natural sciences in the section, "Rules for the Professor of Philosophy".[420] At the end of the first year, the philosophy professor was instructed to begin a fuller discussion where he introduces:


RATIO, ATQVE INSTITVTIO STVDIORVM SOCIETATIS IESV.
Auctoritate Septimæ Congregationis Generalis aucta.
IHS
ROMÆ,
In Collegio Romano eiusdem Societatis.
Anno Domini. M. DC. XVI.
SVPERIORVM PERMISSV.

Coverpage, 1616 Edition of the 1599 *Ratio.* Rare Book/Special Collections Library of Congress, Washington DC.

> …[M]ajor topics of the introduction to physics, such as the divisions of science, abstraction, theoretical and practical science, subordination, the difference of method in mathematics and physics, which is treated by Aristotle in the second book of the *Physics*. . . . "[421]

Mathematics is reduced to a brief section that outlines rules for professors of mathematics. Three rules are listed, which include spending "three quarters of an hour of class time in explaining the *Elements* of Euclid to the students of physics."[422] Geography or astronomy, or "similar matter which the students enjoy hearing about" was to be added after two months.[423]

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[419] Latin, Greek, Hebrew, scripture, theology, philosophy, logic, physics, meteorology, moral philosophy were the other subjects.

[420] *The Jesuit Ratio Studiorum of 1599*, 40.

[421] "Rules of the Professor of Philosophy", *The Jesuit Ratio Studiorum of 1599,* Section 9, #5.

[422] Ibid., 124.

[423] Ibid., 124.

In "Rules for the Provincial", a provision is made for students who had an inclination for further study in mathematics:

> In the second year of philosophical study all students are to attend a course in mathematics for a period of about forty-five minutes daily. Those who show an aptitude and bent for this discipline should be given an opportunity to pursue it further under private instruction after completing the general course.[424]

The large public mathematical displays envisioned by Clavius remained in the form of a "celebrated mathematical problem in the presence of a large gathering of students of philosophy and theology,"[425] but were reduced to a bimonthly event. The third rule adds that "once a month, generally on a Saturday, the class period should be given over to a review of the subject matter completed that month."[426]

The lack of emphasis given to mathematics and mathematical sciences in the document leaves the reader with several questions: was the absence of mathematics and the new sciences in the *Ratio* a dismissal of Clavius' efforts, an attempt to refocus the Society's pedagogy towards the humanities, or a desire on the part of superiors to build a stronger philosophical and theological consensus amongst its members? The final *Ratio* was heavily weighted with Aristotelian philosophy and Thomistic theology that emphasized rhetoric, elocution and Roman classical literature. Did the *Ratio* committee assume that the value and long term effects of the mathematical sciences were transitory or inconsequential? Clavius' insistence upon mathematics and its place in the Society's *Ratio* may have been prophetic, but the timing was too early for the Jesuits to fully understand the impact and influence the mathematical sciences would have. In 1599, the full

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[424] "Rules of the Provincial", Ibid., 8, Section 19, #20.
[425] Ibid., 124.
[426] Ibid., 124.

import of the Copernican revolution and the mathematical sciences was not yet fully realized. Galileo's public criticism of Aristotle's cosmology and challenge to the incorruptibility of the heavens,[427] was still in germination. The Galilean trials were more than a decade away. The reduction of mathematics from a robust and integrated program of study in early drafts of the *Ratio* to a collection of cursory prescriptions in the final draft signals a shift within the Society during the forty years of its production. The early enthusiasm of Clavius' mathematics academy had dimmed in the Society's official pedagogic plan as the possibility of bridging the two systems appeared to be increasingly improbable.

The Jesuits, burdened by a self-imposed mandate of balancing adherence to orthodox tradition with innovative strategies for religious purposes, struggled for unity within their ranks. As the mathematical sciences gradually departed from the Ancient and Scholastic corpus, the Jesuits' contemporaries in other religious orders suffered a lesser fate by remaining engaged, for the most part, in the practice of Scholastic theology, Aristotelian philosophy and traditional methods of evangelization. Members of other religious orders chose whether or not to enter into the controversy, but those who remained in the traditional work of theology and philosophy had less to reconcile or defend. Conversely, the Jesuits' contemporaries in science who collaborated with them and sometimes competed against them for notoriety and patronage also were less encumbered than the Jesuit priest-mathematicians. Connections to patronage and ecclesiastical approvals presented political challenges for leading figures like Brahe, Galileo and Kepler, but they worked as individuals who were not corporately aligned.[428] As a result, they had no internal

[427] Annibale Fantoli, *Galileo, for Copernicanism and for the Church* (Cambridge: International Society for Science and Religion, 2007), 71.

[428] See Mario Biagioli, *Galileo Courtier: The Practice of Science in the Culture of Absolutism* addresses the complexities of fluctuating political, ecclesiastical and social circumstances and competition amongst practitioners to secure the confidence and patronage of influential patrons.

and external narrative to reconcile, nor were they bound to the same levels of accountability. Practitioners of the mathematical sciences may have concerned themselves with solving discrepancies between cosmological phenomena and passages of Scripture, but they were not compelled by obedience to do so.

The Jesuits were unique in their dual investment as evangelizers and mathematicians. Few of the Jesuits' contemporaries in the mathematical sciences struggled to maintain credibility in both sacred and secular worlds in the way in which the Jesuits did. Practitioners of the mathematical sciences were not averse to religion, but seldom did any take upon themselves a vow of religion or felt bound to uphold and publicly defend religious doctrine as the Jesuits were. The Society not only invested themselves in mathematics, they used the mathematical sciences to leverage credibility as part of a larger enterprise of evangelization in the Catholic Reformation. They grounded their reputation upon the ability to be recognized as credible in both realms, even as the circumstances of their age and the changes taking place in religion and science imposed real limits upon this possibility.

Reactions to the *Ratio*

The *Ratio* defined an authoritative pedagogy that was designed to preserve the Society's intellectual patrimony, create a common educational experience for all the schools of the Society, and contribute to the broader Catholic intellectual culture. However, the reception of the Society's forty-year study and final promulgation of the document was less than unified. After reviewing the theology sections of the 1586 *Ratio*, Robert Bellarmine reported that of the 597 propositions in the document, 77 were against the mind of St. Thomas,[429] and the final document scattered propositions throughout, seemingly without regard to any order, creating an impression that the Society lacked clarity with regard to a definitive corpus of doctrinal teachings.[430] The German provincial, Paul Hoffaeus (d. 1608), wrote to Father General Aquaviva (d. 1615) from Germany:

> About the *Ratio Studiorum*, even though it's not easy for me to criticize my superiors' administrative policies, nevertheless, and I say it only for the common good, I fear that unless Your Reverence provides greater incentives to Ours, the project won't have a happy ending. We are used to old ways very different from the new *Ratio*; we cling to them so closely that I don't think we try to overcome the obstacles we meet. We debate rather than experiment to see what to keep, discard, or ignore. Many men here like the *Ratio*, but others don't, and are unwilling to overcome their difficulties. Enough! It's already too much.[431]

General Aquaviva' s reply to Hoffaeus was unequivocal:

> Your Reverence should scotch a rumor (supposedly rampant in some places) that the *Ratio* is not to be observed the same way everywhere. Unless they desist, rumor mongers are to be confronted openly. I am sure you will do so, and they will realize the rumor is false, especially since the *Ratio* has been received and put into practice in many provinces with no delay and with good results.[432]

To avoid controversy, some Jesuits chose to be less direct than Hoffaeus and adopted a position of minimal exposure as a way of navigating between the proximate threat of censorship from superiors and the possibility of losing vital credibility from among their peers.[433] At the Collegio Romano and in other places, mandates from superiors to adhere to the orthodox standards outlined in the *Ratio* continued to be interpreted loosely as mathematical scientists in the Society

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[429] Also known as *Delectus Opinionum,* or theological opinions that the Jesuits were not bound to hold. Lukacs and Cosentino, *Church, Culture and Curriculum,* 30.

[430] Ibid., 30.

[431] Quoted in Lukacs and Cosentino, *Church, Culture and Curriculum,* 39.

[432] Ibid., 39.

[433] Ugo Baldini and Alfredo Dinis, "Giovanni Battista Riccioli and the Science of His Time," in *Jesuit Science and the Republic of Letters,* Mordechai Feingold, ed., (Cambridge, MA: MIT Press, 2003), 196.

waited for the tension to subside.[434] Christoph Grienberger requested that he be removed from the spotlight and left alone in his laboratory. When asked to offer private lessons to the son of a nobleman, Grienberger questioned whether he was the best candidate for the position, demurring that "this task… should really require not a German but a Tuscan, who would be more affable than me."[435] The disjunction is most notably seen in men like Christoph Scheiner who, under the direction of superiors, published three letters on sunspots in 1612 under a pseudonym in case his observations were erroneous.[436] The inability of the Jesuits to resolve discrepancies between the internal and external narratives of the relationship between natural philosophy and mathematics continued into the seventeenth century as Jesuit cosmologists gradually exchanged an Aristotelian view of cosmology for a Tychonic or hypothetically-Copernican view.[437]

The Society's internal obligation to uphold orthodox teachings and the absence of internal consensus coupled with a desire to remain relevant in the public square created challenges for the early modern Jesuits. Superiors attempted to create greater unity by means of reinforcing the implementation of the *Ratio Studiorum*, but responses from members of the Society remained divided, particularly amongst the mathematicians and mathematical scientists.

After his death, Clavius' prodigies at the Collegio Romano continued to advocate for the place of mathematics in the Society. A student of Clavius, Paul Guldin, developed a hierarchy within mathematics and asserted that al-gebra or "divine'gebra" as he termed it, was the most

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[434] Peter Dear, *Science, Culture and Popular Belief in Renaissance Europe*, Stephen Pumfrey, Paolo Rossi and Maurice Slawinski, eds. (Manchester, NY: Manchester University Press, 1991), 135.

[435] Michael Gorman, "Mathematics and Modesty in the Society of Jesus," *The New Science and Jesuit Science: Seventeenth Century Perspectives* (Dordrecht, The Netherlands: Kluwer Academic Publishers, 2003), 14 [fn 57].

[436] William Wallace, *Galileo and His Sources* (Princeton, N.J.: Princeton University Press, 1984), 147.

[437] Lattis, *Between Copernicus and Galileo,* 35.

noble among the mathematical sciences because it formed a unique continuum between continuous and discreet reality:

> Algebra treats numbers as lines, planes, and bodies; and conversely treats these as numbers, and in some manner transforms lines into numbers and numbers into lines by some miraculous art.[438]

Christopher Grienberger took the position that mathematics was applicable to "any physical quality, including motion,"[439] a concept that signaled a departure from the medieval concept that a correlation existed between motion, change and disorder.[440] Here Grienberger blurs the distinction between abstract and concrete reality, inverting a traditional separation of artificial and natural entities and making nature, including motion, mathematical.[441]

Solid and safe: maintaining orthodoxy amidst change

In 1613, General Aquaviva published the *Ordinance for the solidity and uniformity of doctrine.* Soon after, a noticeable tightening by the broader ecclesiastical community cast a shadow over Galileo and the reputation of the Jesuits suffered as well.[442] In 1614, the Florentine Jesuit Giovanni Bardi presented a defense of Galilean mechanics at the Collegio Romano.[443] In a letter

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[438] Quoted in Feldhay, *Galileo and the Church,* 119 fn 45.

[439] Gorman, "Mathematics and Modesty in the Society of Jesus", 22.

[440] Ofer Gal, Raz Chen-Morris, "Nature's drawing: problems and resolutions in the mathematization of motion" *Synthese* Vol. 185, No. 3, Seeing the Causes: Optics and Epistemology in the Scientific Revolution (April 2012), 13.

[441] Ibid., 19.

[442] Francesco Paolo de Ceglia, "*Addito Illa Non Videtur Edenda*: Guiseppe Biancani, Reader of Galileo in an Unedited Censored Text," in *The New Science and Jesuit Science: Seventeenth Century Perspectives,* M. Feingold, ed., (Dordrecht: Kluwer Academic Publishers, 2003), 173.

[443] Ibid., 173.

to Galileo that year, Bardi reveals the difficulty of maintaining an Aristotelian position in light of Galileo's recent developments:

> A Fr. Grienberger told me that if he hadn't had to have respect for Aristotle, whom they are not allowed to oppose in any way by order of the General, but must always save, he would have spoken more clearly than he did, because in this [matter] he is entirely on your side; and he told me that it is no wonder that Aristotle is in opposition, because he was most clearly mistaken in that which Your Lordship told me once about those two weights falling earlier or later.[444]

Bardi was confronted with the challenge of reconciling the empirical alternatives offered by the mathematical sciences with the traditional view of the Ancients, "whom they are not allowed to oppose in any way by order of the General."[445] The difficulty the Jesuits faced can be seen in Grienberger. Less discreet than his teacher Clavius, he retorted to Darius Tamburelli, a Jesuit professor of mathematics at Parma who criticized Galileo's lunar observations:

> Let us admit even that there are not mountains on the moon, or that Galileo has not taken the true diameter of this planet. Is then, this a reason for rejecting all the affirmations of Galileo? May Your Reverence not be offended at this admonition, and, if possible, may you speak of Mr. Galileo as a mathematician in a proper manner. I appreciate that not all of what he says is according to the faith; but, on the other hand, certain things said by him are not so absurd that he does not deserve to be excused rather than to be given a public rebuff.[446]

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[444] Bardi to Galileo, Rome, 20 June 1614, OG XII p. 76. "*[D]ovendosi fare uno di questi problemi et essendo stato destinato a me, mi domandò il Padre Ghambergier di che cosa volevo farlo, proponendomi alcune altre cose; hora io gli dissi che haria desiderato di fare di qualche materia simile a questa, e cosi lui prese questa, che non credo che sii per apportarli pocho gusto, perchè è tutta conforme al suo parere, anzi quello istesso, con l'aggiunta di quelle doi esperienze che non possono se non conferire alla sua sentenza. E mi ha detto il Padre Ghambergier, che se non havessi hauto rispetto ad Aristotile, al quale loro per ordine del Generale non possono opporsi niente, ma lo devono sempre salvare, haria parlato più chiaro di quello che ha fatto, perchè in questo lui ci sta benissimo; e mi diceva che non è meraviglia che Aristotile sii contro, perché anchora si è ingannato chiarissimamente in quello che V.S. anchora mi diceva una volta di quei doi pesi che caschano prima o poi* [Trans. Sr. M Angelica Neenan].

[445] Ibid., xii.

[446] Quoted in Paschale D'Elia, *Galileo in China,* Trans. Rufus Suter and Matthew Sciascia. (Cambridge, MA: Cambridge University Press, 1960), 13. Christopher Grienberger to Darisu Tamburelli, *Archivio della Pontificia Università Gregoriana* 534, f. 87r.

Grienberger underscores a disjunction between the Society's internal and external narratives; he is bound to publicly uphold Aristotelian cosmology but compelled to defend privately Tamburelli's public criticism of Galileo. Another pupil of Clavius, Josephus Biancani, whose *Sphaera* (1619)[447] was the first to recommend the Tychonic system, was more open in his sympathy for Galileo's ideas. Later Biancani received a censure for his comments,[448] and part of his commentary on Aristotle's *De caelo* was removed by superior Giovanni Camerota who said that:

> [It] should not be published since it is an attack on Aristotle and not an explanation of him (as the title indicates). Neither the conclusion nor the arguments to prove it are due to the author, but to Galileo. And it is enough that they can be read in Galileo's writings. It does not seem to be either proper or useful for the books of our members to contain the ideas of Galileo, especially when they are contrary to Aristotle.[449]

During the nearly forty years of his tenure, Father General Aquaviva responded to internal tensions by calling members of the Society back to the teachings of Aristotle and Aquinas. In the *Ordinance for the solidity and uniformity of doctrine* (1613), sent to all Jesuit provinces, he strenuously criticized departures from traditional sources, saying, "that the opinions that are taught in philosophy are subservient to theology, and that our philosophers follow Aristotle alone, wherever his teachings are not at variance with Catholic truth."[450] Jesuit astronomers and mathematicians negotiated a compromise in lecture halls as a number of Jesuit natural philosophers continued to

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[447] *Sphaera* was written in 1615 and published after the *Decree of the Index* (1616), in Bologna in 1619.

[448] Wallace, *Galileo and His Sources*, 147; also in Dear, *Science, Culture and Popular Belief in Renaissance Europe*, 135.

[449] From recovered censored material, quoted in de Ceglia, "*Addito Illa Non Videtur Edenda,"* 162.

[450] Claudio Aquaviva , S.J., Ordinatio pro soliditate et uniformitate doctrinae, ad omnes praepositos provincials S.I., Rome 14 December 1613, in Monumenta Paedagogia v. vii, 663. *Sed insuper videat provincialis diligenter et efficiat, ut opiniones, quae docentur in philosophia, theologiae suserviant, nostrique philosophi unum sequantur Aristotelem, ubicunque illius doctrina nihil a catholica veritate dissidebit* [Trans M. Looney].

use Galileo's mathematical studies of motion,[451] even as they continued to teach Aristotle in their classes.

In 1616, the Seventh General Congregation posed a question whether the philosophers and theologians of the Society could be commissioned to write "solid" *summae* that would "embrace . . . the best received opinions of the Society adapted from the writings of Saint Thomas and our fathers," so that "Ours" would not meander with such freedom through the different preferences of theologians and philosophers."[452] The Jesuit council rejected the proposal for, "various serious reasons brought to light by many members, nor did the present seem a suitable time to treat this matter."[453] The "various reasons" are not explained, but it is significant that the discussion took place seventeen years after the promulgation of a definitive Jesuit pedagogical program and seventy-six years after the Society's founding.

Jesuits' external challenges: heliocentrism

In addition to the internal battles of natural philosophy, mathematics and the implementation of the 1599 *Ratio*, the Jesuits faced external battles as members of the Society negotiated major epistemological shifts in natural philosophy and the mathematical sciences, while struggling to maintain credibility in the public spaces of lecture halls, laboratories and published texts. Externally, the Jesuits maintained a well-trained corporate identity, but internally they were unable to achieve consensus regarding the relationship of natural philosophy to the mathematical

[451] See Francisco Suarez, *Disputationes metaphysicae* (1597) and Luis de Molina on free will and predestination in Dear, *Science, Culture and Popular Belief in Renaissance Europe*, 135.

[452] From the *Decree of the Seventh General Congregation, 1616*, in *For Matters of Greater Moment: The First Thirty Jesuit General Congregations*, John W. Padberg, S.J, Martin D. O'Keefe,S.J., John L. McCarthy S.J., Ed and Trans., (St. Louis MO: Institute of Jesuit Sources, 1994), 276.

[453] Ibid., 276.

sciences, especially as the new experimental sciences challenged long standing proposals of Ancient natural philosophy. The most illustrative example of this tension is found in the central controversy between ancient geocentric and early modern heliocentric theories.

Public response to heliocentrism developed slowly during the first half of the sixteenth century,[454] and Andreas Osiander's (d. 1552) preface in *De Revolutionibus* carefully positioned his mentor's work as a mathematical hypothesis rather than an attempt to explain the structure of the universe.[455] Prior to 1616, general silence prevailed among astronomers of the time who either taught heliocentrism as a hypothesis among other hypotheses or dismissed its plausibility. Pope Paul III, who had established the Roman Inquisition in 1542, received the work favorably but was presumably occupied with matters of the Council. *De Revolutionibus* was released on the eve of the Council of Trent (1545) and there is no mention of Copernicus' theory in the acts of the Council. In the latter part of the sixteenth century the Catholic Church adopted a moderate stance that heliocentrism was a theory for which there was no convincing proof.

The medieval approach to the centrality or immobility of the earth was foundationally Aristotelian. Within Aristotle's model of crystalline spheres, natural philosophers were given the freedom to posit variant theoretical models of the planetary motion. Clavius along with other Jesuits who were formed years later in this tradition such as Bartholomew Arnicus (d. 1649) along with the members of the College at Coimbra believed that the natural heaviness of the earth placed

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[454] Fantoli, *Galileo for Copernicanism,* 23.

[455] See: Robert S. Westman, "Proof, poetics and patronage: Copernicus' preface to *De revolutionibus*", in *Reappraisals of the Scientific Revolution*, ed. by Lindberg, David C., Robert Westman, (Cambridge, 1990), 167–205, and Geoffrey Blumenthal,. "Diplomacy, Patronage, and the Preface to *De revolutionibus*". *Journal for the History of Astronomy* 44, no. 1 (February 2013): 75–92.

it at the lowest and most remote position in the heavens.[456] The Dominicans followed Aristotle's model and some of the friars made early attempts to refute heliocentrism, with limited success. The Dominican Bartolome Spina, Master of the Sacred Palace during the reign of Pope Paul III, prepared a dossier in condemnation of Copernicus but died in 1546 before he was able to deliver his verdict.[457] Giovanni Maria Tolosani (1470- 1549), a Dominican and friend of Spina carried out the work begun by Spina by severely criticizing Copernicus with his work *On the Truth of Sacred Scripture* written in 1544, but never published his work. Contrary to his expectations, Tolosani was not invited to discuss his work at the Council of Trent. Within the work, Tolosani, an accomplished astronomer, demanded that the conclusions of physics and astronomy be dependent upon the Scriptures. His argument appealed to the authority of the popes, previous councils and his own works, which included a treatise on the reform of the Julian calendar,[458] but Tolosani's efforts to refute heliocentrism were ignored by the Church and were largely unnoticed by the scientific community.[459]

Protestant responses to heliocentrism traced a similar path, requiring that the composition and order of the universe align with the Scriptures. Protestants, much like their Catholic counterparts, lacked uniformity amongst themselves and the wider community: Melanchthon (d. 1560) originally opposed the work because of its incompatibility with Scripture but later shifted his position,[460] and Georg Joachim Rheticus (d. 1574), a Protestant professor of mathematics from

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[456] Ed Grant, "The Partial Transformation of Medieval Cosmology by Jesuits in the Sixteenth and Seventeenth Centuries," in *Jesuit Science and the Republic of Letters,* Mordechai Feingold, ed., (Cambridge, MA: MIT Press, 2003), 129.

[457] Fantoli, *Galileo for Copernicanism,* 26.

[458] Robert Westman, "Competing Disciplines: The Copernicans and the Churches" in *The Scientific Revolution: The Essential Readings*, Marcus Hellyer, ed. (New Jersey: Blackwell Publishing, 2003), 58. See also Kristeller, *Renaissance Thought and Its Sources*, 48-49.

[459] Ibid., 89.

[460] Deason, G. B. "The Protestant Reformation and the Rise of Modern Science." *Scottish Journal of Theology* 38, No. 2 (May 1985): 227.

Wittenberg who preceded Osiander as Copernicus' first disciple approached the difficulty by seeking to reconcile the inconsistencies between heliocentrism and the Scriptures.[461]

Outside of confessional circles, Early Modern mathematicians were not united on the topic as well. Tycho Brahe's voluminous collection of data on the positions of the sun, planets and stars left him suspended between Aristotle and Copernicus. The second edition of *De Revolutionibus* was published in 1566 and gained a few adherents, including Petrus Ramus (d. 1572), Giovanni Battista Benedetti (d. 1590) and Giordano Bruno (d. 1600). By 1595, Galileo's work on the tides had shifted his allegiance toward a Copernican model.[462] Momentum continued to build after the execution of Bruno, about the time that the thirty-six-year-old Galileo arrived in Venice. Within five years, Galileo had published the first edition of *Stella Nova Serpentarii* (1604) was published.[463]

Jesuits respond to heliocentric theory

Responses to heliocentric theory among the Jesuits were predictably varied. Some took on the task of publicly attacking heliocentrism by means of Scripture or by substituting other cosmological theories. The Jesuit theologian John Lorinus (d. 1634) attacked Copernicus' heliocentric theory in his *Sphaera* using the writings of "our Clavius" along with biblical passages which supported the immobility and the centricity of the earth.[464] Most Jesuits, including Clavius, followed Brahe's model[465] that used the Copernican model of inner planetary movement while maintaining a geocentric universe.

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[461] Westman, "Competing Disciplines," 82.
[462] Fantoli, *Galileo for Copernicanism,* 28.
[463] Ibid., 63.
[464] *New American Bible*, Eccl. 1:4-5; Ps. 18: 6-7; Ps 103: 5
[465] The Tychonian model set the earth at the center of the universe while the sun and moon orbited the central, stationary earth with the planets in motion around the sun. See Ed Grant, "In Defense of the Earth's

The Jesuits were influential in spreading the Tychonic model, particularly after the Galilean controversy began.[466] Niccolò Cabeo's 1629 book on magnetism and an astronomical work by Giovanni Battista Riccioli (d. 1671) also supported the Tychonian model.

Figure 2: Riccioli, Almagestum novum (1651), frontispiece. Rare Book/Special Collections Library of Congress, Washington DC.

In 1651, Riccioli proposed a third model between Ptolemy and Copernicus by using a modified version of the Tychonic system. Riccioli's primary argument for the immobility of the earth was not drawn from mathematics or astronomy, but from Scripture. He divided biblical texts into those that supported the motion of the sun and a geostatic universe[467] and employed the scriptures to determine the true model. The frontispiece for the *New Almagest* shows the scales tipping away from Copernicus' system towards his own which features a diagram of the planets Mercury, Venus, and Mars encircling the sun; while the moon, Saturn, Jupiter, the Galilean moons and a comet orbit the Earth. The goddess of justice, Astrea, upholds Riccioli's model over Copernicus' as Ptolemy and his outmoded model lie beneath her feet.[468] As the Jesuits struggle to reconcile the new cosmological theories with traditional texts, skepticism about a geocentric universe was augmented by

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Centrality and Immobility: Scholastic Reaction to Copernicanism in the Seventeenth Century," *Transactions of the American Philosophical Society, New Series* 74 (1984): 66.

[466] Isabelle Pantin, "New Philosophy and Old Prejudices: Aspects of the Reception of Copernicanism in a Divided Europe," *Stud. Hist. Phil. Sci.* 30 (1999): 247.

[467] Grant, "The Partial Transformation of Medieval Cosmology,"134.

[468] Anna Friedman, *The Universe Unveiled* (Cambridge, UK: Cambridge University Press, 2000), 223.

observations and calculations that corroborated with those of Galileo and Kepler.[469] As evidence in support of heliocentrism mounted, Clavius' posture of neutrality became increasingly difficult to maintain.

Between the Galilean Trials 1616-1633

Chapter three described the relationship between Galileo and the Jesuits, particularly Clavius, which was marked by mutual respect and cautious collaboration. The Jesuits' presence in Rome was opportune for Galileo and he often visited Clavius when he was there. Clavius observed and validated Jupiter's moons, and Galileo presented on Jupiter's satellites and the irregular surface of the moon to the astronomers at the Collegio Romano, who listened attentively to the Florentine mathematician.[470] Fantoli notes a presentation by the Jesuit Odo Van Maelcote (d. 1615), "*Nuncius Sidereus* Collegii Romani", who presented Galileo's discovery as confirming the Jesuits' findings.[471] Clavius and his students defended Galileo after the *Sidereus Nuncius* was published in 1610 and even constructed a small telescope to verify the phenomena.[472] When Robert Bellarmine asked Clavius to verify Galileo's claims about sunspots, a concept that challenged the Aristotelian understanding of the incorruptibility of the heavens, the phases of Venus that compromised the Ptolemaic system and the nature and composition of the Milky Way, Clavius upheld Galileo's *observations*.[473] A point of departure emerged within a few years, however, as Galileo's notion of science based on experimentation and mathematics and his

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[469] Mario Biagioli, "Replication or Monopoly? The Economics of Invention and Discovery in Galileo's Observations of 1610," in *Galileo in Context*, Jurgen Renn, ed., (Cambridge, UK: Cambridge University Press, 2001), 300.

[470] Fantoli, *Galileo for Copernicanism,* 115.

[471] Ibid., 125.

[472] William Wallace, *Galileo and His Sources*, 282.

[473] Ibid., 282.

discovery of the phases of Venus made a hybrid position between natural philosophy and mathematics no longer satisfactory. After the death of Clavius, despite the support of Grienberger, Biancani and other Jesuit mathematicians, Galileo gradually distanced himself from the Jesuits at the Collegio Romano.[474] Soon after, exchanges between Galileo and the Jesuits assumed a formality that reflected the tension of the times. In 1616, Robert Bellarmine, serving as the Cardinal Inquisitor to Pope Paul V, sent a letter to the Carmelite Antonio Foscarini[475] (d. 1616) complementing him and Galileo for publicly taking a hypothetical position on the Copernican position:

> First, I say that it seems to me that your Paternity and Mr. Galileo are proceeding prudently by limiting yourselves to speaking suppositionally and not absolutely, as I have always believed that Copernicus spoke. For there is no danger in saying that, by assuming the Earth moves and the sun stands still, one saves all of the appearances better than by postulating eccentrics and epicycles; and that is sufficient for the mathematician.

Later that year, Bellarmine informed Galileo that the pope had determined that the Copernican system was contrary to Church teachings and asked Galileo refrain from defending the theory.[476] Publicly, the Jesuits managed to keep a united front during the years between the Galilean trials. Within their ranks, however, mathematicians, natural philosophers, and scientists were less than united[477] as is evidenced by textbooks which were labeled as "Aristotelian" or "Peripatetic" but contained a wide variety of content.[478]

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[474] Ibid., 282.

[475] Farina, Fabio J. A. *Four Treatises for the Reconsideration of the History of Science*, (New York: iUniverse Inc, 2003) 25.

[476] Joseph Pitt "The Heavens and Earth: Bellarmine and Galileo" in *Revolution and Continuity: Essays in the History and Philosophy of Modern Science*, Peter Barker and Roger Ariew, eds, (Washington DC: CUA Press, 1991), 132.

[477] Marcus Hellyer, "'Because the Authority of My Superiors Commands': Censorship, Physics and the German Jesuits". *Early Science and Medicine* 1 (Oct., 1996): 326.

[478] Irving A. Kelter, "The Refusal to Accommodate: Jesuit Exegetes and the Copernican System," *The Sixteenth Century Journal* 26 (Summer, 1995), 284.

Conclusion

The optimism and confidence of the men of the Society is echoed in the words of Jerónimo Nadal, a Jesuit from the first generation of Jesuits who exhorted his brothers at Alacalá in 1561 to be as accomplished in as many disciplines as possible for the good of the Society:

> The Society wants men who are as accomplished as possible in every discipline that helps it in its purpose. Can you become a good logician? Then become one! A good theologian? Then become one! The same for being a good humanist, and for all other disciplines that can serve our Institute . . . and do not be satisfied with doing it half-way![8]

Nearly fifty years later, Leone Santi, the Prefect of Studies at the Collegio Romano admonished members of the Society who stepped beyond what was "solid and safe", declaring that they were sowing not Scholastic theology but their own "fantastic theology", which caused confusion to themselves and disruption to the Church they had promised to serve:

> Scholastic theology signifies none other than that which supposes Aristotelian philosophy. If, therefore, our authors commonly depart from Aristotle, they are not transmitting scholastic theology, but, as some would say, fantastic theology, for each individual forges his own with great confusion and perturbation to the Church.[479]

The early confidence and unity that marked the Society of Jesus was marked by disparity in the ranks and a separation of the internal narrative from what was presented to the public. Separate narratives within the Society led to suspicion regarding the integrity of the Jesuits' message. The 1599 *Ratio*, as the definitive pedagogical compendium for the Society's schools, was reduced in its final drafts to being a handbook of administrative procedures, position descriptions, book inventories and discipline codes whose implementation met with resistance from many quarters of

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[479] Leone Santi, Prefect of Studies, Collegio Romano, 1646; *Dubia et Postulata Praefecti Studiorum Collegii Romanii de formandis Descretis circa Studia*, ARSI 150, Louis Gallagher, Trans. (St. Louis: Institute of Jesuit Sources, 1988), 289.

the Society. Externally, heliocentrism and Galilean science presented plausible alternatives to the Ancients' concepts of order in the universe,[480] posing real challenges to the reliability of traditional natural philosophy.

As the Jesuits carried out their religious mission in increasingly difficult circumstances, they were suspended between two worlds that were drifting apart in the early seventeenth century. The challenging cultural, social and religious circumstances in which they were founded, coupled with an ambition to embrace both sacred and secular realms, created unique challenges for the Society. Rather than sound a retreat and return to the traditional methods of evangelization, the priest-mathematicians continued to invest themselves and their resources vigorously in advancing mathematics and the new sciences for the purposes of evangelization and conversion.

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[480] Ugo Baldini and Alfredo Dinis, "Giovanni Battista Riccioli and the Science of His Time," in *Jesuit Science and the Republic of Letters,* Mordechai Feingold, ed., (Cambridge, MA: MIT Press, 2003), 196.

Chapter Nine
A shift in the order of knowledge

We do not read in the Gospel that the Lord said:
I will send you the Paraclete to teach you how the Sun and the Moon move.
Because he wished to make them Christians, not mathematicians."[481]
-- St Augustine *De Genesi ad Litteram*

The papal bull that granted initial approval for the Society of Jesus, *Regimini Militantis Ecclesiae*, states that the Jesuits were founded that each member might "serve as a Soldier of God beneath the banner of the Cross in our Society".[482] Ignatius of Loyola's small band of companions grew quickly into a legion of well-trained priests who were committed to credal orthodoxy and innovative praxis. Official documents, letters and the evidence of works of the Society testify to the determination of Ignatius and the early Jesuits to advance the Catholic Reformation by engaging with the secular culture in a new way. The Jesuits were committed to missionary expansion and to making use of a school system that would propagate a renewed Catholic intellectual culture. The archives of the Society attest to its level of dedication and investment that included the rigorous formation of personnel, disciplined infrastructure, strategic use of the apostolate and a commitment to the program of reform called forth by the Council of Trent. The Society extended the traditional boundaries of missionary work, literally and figuratively,

[481] Augustine of Hippo, *Genesi Ad Litteram*, Book II, (New York: Paulist Press, 1983), 58.
[482] From the *Regimini Militantis Ecclesiae* (1540), Introduction XXXV. See Antonio M. de Aldama, *Formula of the Institute, Notes for a Commentary*, trans. Ignacio Echaniz, (St. Louis: Institute of Jesuit Sources, 1990), 221.

throughout Europe and in territories beyond the borders of Europe. They enjoyed the support of influential patrons in Catholic Europe and were sought after by bishops for the training of their priests. Men were recruited to the Society and selected for their erudition, physical appearance and social connection. The propriety and prestige of candidates were taken into account in the selection of superiors.[483] As God's soldiers, the Jesuits launched a counter offensive designed to reverse the losses incurred in the Protestant Reformation. Their inception, growth and expansion, particularly the establishment of reputable schools, were surprising to audiences within and outside the Catholic Church. Their energy and zeal reawakened confidence in the Catholic Church as it implemented reforms in the aftermath of the Reformation and the near dissolution of long-established religious orders in Europe.

As the Society's secondary and tertiary schools multiplied across Europe, Asia and the Americas, superiors of the Society called for a draft of a standard pedagogical program of intellectual, social and cultural formation. The *Ratio Studiorum*, promulgated in 1599, was created to provide a single, uniform educational plan within the Society and was designed to be used in secondary and tertiary schools across a wide range of cultural, linguistic and socio-economic settings. Nearly forty years in the making, the *Ratio* was the Society's attempt to create an authoritative standard for its schools that would reinforce doctrinal synthesis, ensure philosophical uniformity, provide a classical foundation in the humanities and a unified methodology amongst its members. The *Ratio* supplied a standardized education for generations of students and teachers. It memorialized the Society's patrimony for the formation of candidates and communicated a systematic educational program to internal and external audiences.

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[483] Ref: 1550 *Constitutions*. Ignatius of Loyola, *The Constitutions of the Society of Jesus*, George E. Ganss, S.J., trans. (St. Louis, MO: Institute of Jesuit Sources, 1970), Part VII, #732-36, 311.

In addition to the publication of the *Ratio,* Ignatius' vision for the Society included the creation of an international network of correspondence within the Society which enabled information to pass from remote mission territories. In particular, knowledge of natural scientific philosophy and natural discoveries moved through circular letters that were written at the periphery of the Society's outermost boundaries to its Roman core. Missionaries within the Society boldly extended the limits of missionary commitment by exiting their own cultures and entering into host cultures. In some cases, Jesuit missionaries saw their having exchanged their native culture for a host culture as a way to attain a level of authenticity with local populations and to enhance the effectiveness of their efforts to evangelize. The Jesuits' activity and the works they performed across a wide variety of cultures were characterized by the definitive decision to immerse themselves in the affairs of chanceries, courts, public squares and places of influence. Ignatius of Loyola wrote to the members of the Society of a "special obligation" they were under to serve Europe's nobility. Many early Jesuits were trained as court diplomats who would serve in key positions at court and within the Catholic Church. They made a conscious decision to withdraw from spaces were customarily occupied by members of a religious society to enter new domains, or as Ignatius would say, to "go in by their door in order to come out by our own door".[484] A calculated risk accompanied the decision, particularly in the shifting tides of post Reformation, post-Copernican Europe. If, in the confluence of events the host culture into which the Jesuits entered changed significantly, what, if anything, was compromised in their exchange?

The scope of this thesis was limited to a discussion of events that occurred in the broader context of a shifting European society in the sixteenth and seventeenth centuries. Special

[484] Ignatius Loyola to Fathers Salmeron and Broet, Rome 1545, *in Letters of St. Ignatius of Loyola,* ed. William John Young (Chicago: Loyola University Press, 1959), 51.

consideration was given to the influence these events had upon the development of religion and the sciences within the Society of Jesus, and the impact external events had upon the Society's capacity to engage secular society according to its own terms. The Society of Jesus was founded at a moment in history when fundamental assumptions about nature and super-nature were undergoing radical change. The Jesuits, who were invested in both the natural and supernatural worlds, were both shaped by and shapers of the movements of their age. The Jesuits' pedagogical program, rigorous training, missionary commitment and investment in a wide array of works *did* bring credibility to the Society and renewed confidence within the Catholic Church. But in the course of the approximately 150 years from the foundation of Christopher Clavius' academy until its dissolution in the late seventeenth century (the actual date is uncertain) the shifts that occurred in the wider European culture and within the Society were intertwined and multifaceted. As the Society's members were invested in the mathematical sciences as priests, a separation occurred within and outside the Society that reflected a greater crisis that was unfolding in Europe. Certainty in the realms of knowledge, authority and belief experienced new scrutiny within European culture. This impacted the atmosphere in which the Society of Jesus was formed and to an even greater degree, it influenced the way they carried out their work as evangelizers.

Within the context of the early Society of Jesus, the story of Christopher Clavius and his companions offers a view into the unique challenges that the mathematical sciences presented in both sacred and secular realms in the sixteenth and seventeenth centuries. Clavius, his collaborators and protégés embodied the spirit of the Society and the idealism of the age: a broad vision of seemingly limitless expansion coupled with an elaborate strategy, and confidence that their endeavours would meet with success in Europe and the mission territories. Clavius' corpus of writings, the skilled men who were drawn to the mathematics academy and the productivity of the academy across many decades at the Collegio Romano reflect a spirit of optimism and confidence that was incarnated in Clavius. His vision for the new man of science and the vocation of the priest-mathematician stretched beyond the boundaries of Rome and regions of Catholic Europe to remote missionary lands whose language, culture customs and religious experience were far removed from the centre of Catholic renewal.

The mathematics academy at the Collegio Romano was formed around subjects that were secular, but its purpose was religious. The men of the academy forged a unique kind of engagement between the sacred and secular realms. It was founded to prepare mathematicians who would advance the mathematical sciences with the goal of advancing the work of the Catholic Reformation. Mathematics and the new sciences carried a quality of certainty and conviction that moved men's minds (to paraphrase Clavius) from those things that were doubtful or probable to things that were *true*. The academy bolstered the credibility of the Society and by extension, the Catholic Church to Catholic and non-Catholic populations. Its inception and growth signalled to Clavius and those sympathetic to his cause, a confidence in the power of mathematics that grew strong enough to move an idea from a private inspiration to a consciously public, highly organized, well-funded, international movement. Clavius' dedicated labour resulted in an academy that left an imprint upon the scientific culture of sixteenth century Europe, the Society itself, missionary territories and the Catholic intellectual culture of Europe.

As the story of Clavius' academy unfolds across the course of half a century, however, the mathematics academy that began as tool for evangelization to advance the credibility of the Society took a surprising turn. Rather than engendering confidence in the Society, the development of mathematics and the mathematician as a missionary vocation created a disjunction between internal and external narratives, which resulted in division and tension within the Society and amongst the populations where the Jesuits served. The same movement that was instituted to remove doubtful or even probable things by means of an expressed, if abstracted, truth led to confusion and suspicion. Soon the early successes of the Society began to turn against them. The confidence and certainty for which they were known turned to criticism, suspicion, and in some cases, rejection. Once hailed as the vanguards of orthodoxy and defenders of the papacy, the Jesuits were now recast as untrustworthy and even impostors. Why did the story of the Jesuit priest-mathematicians take the direction it did?

The greater crisis of authority, knowledge and belief that occurred within the Catholic Church in Europe was accompanied by an erosion of confidence in the authority of the core teachings of the Ancients and Scholastics. This caused within the Society two main categories of separation. The first was a disjunction in the order of knowledge, particularly in the sciences. The second, an effect of the first, was a separation of internal and external narratives as the priest-mathematicians carried out their work as scientists and evangelists in Europe and in territories that were far removed from the Collegio Romano.

A New Order of Knowledge

The first disjunction that occurred in the Society in the late sixteenth and seventeenth centuries was a separation of knowledge. The traditional order of the disciplines and the boundaries between those disciplines were disrupted by the introduction of the mathematical sciences. The tension that existed between the natural philosophers and the mathematicians in the Society may have been influenced by political motives but their underlying concern was related to the reordering of knowledge within the sciences, accompanied by a blurred distinction between domains. The second category of disjunction flowed from the first; the tension surrounding the reordering of knowledge that included a re-valuation of its place in the hierarchy of knowledge and led to inconsistencies between the internal and external narratives of the Society. A separation developed between the men of the mathematics academy and members of scientific societies in Europe, ecclesiastical officials in the Catholic Church, audiences in missionary territories, and colleagues and superiors within the Society.

To reduce the internal battle that Clavius and his students waged with natural philosophers and other members of the Society to a misunderstanding between subjects and superiors is to tell only half the story. The tensions were persistent and entrenched, but the source of the difficulty within the Society came more from a disagreement about the place of mathematics in the hierarchy of knowledge and the effect a reordering of knowledge would have upon the disciplines. It created ambiguity between domains, compromised the integrity of the individual disciplines and altered the limits traditionally set by natural philosophy, mathematics and the sciences. The new standard for certain knowledge was no longer measured by the ability to understand the nature of the world but in the ability to solve problems.[485]

In the first part of the sixteenth century, heliocentrism was held as a theory that garnered occasional but minimal attention. Galilean science was still decades away. By the end of the century the scenario had changed, and the new mathematical sciences provided a pathway for developments that would shift the fundamental understanding of the structure and composition of the natural world. For Aristotle, the natural philosopher or the physicist was concerned with physical bodies and their essential attributes, using volume, lines and points to measure the *limits*

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[485] William Wallace. "The Intelligibility of Nature: A Neo-Aristotelian View" In *Galileo, the Jesuits and the Medieval Aristotle* (Hampshire, UK: Variorum, 1991), 36.

[485] In *Modus quo disciplinae*, he encourages his colleagues to refrain from telling students that the "mathematical sciences are not sciences, do not have demonstrations, abstract from the being and the good, etc…," as a reprimand his fellow Jesuits who did not support the mathematics program within our outside the halls of the colleges. Cited from English Translation of *Modus quo disciplinae* in Wallace, *Galileo and His Sources*, 2014, 137.

of physical bodies.[486] The mathematician treated physical qualities too, but in abstraction. This was a less certain means of understanding, because the abstract, discrete quality of mathematics made it incapable of addressing causal relationships. The discrete nature of mathematics prevented it from considering the whole, which made it a subspecies of physics that could confirm observations in nature by quantification but lacked the sufficient capacity to provide suitable explanations for earthly and celestial phenomena. The Ancients believed that the goal of knowledge was to attain the knowledge of things in a way that was perfect, whole and eternal. The discrete knowledge of mathematics was a *reduction* of that potential, that imposed unnecessary limits on knowing reality.[487]

In addition to the limits imposed by mathematics upon certain knowledge, the Ancients understood that a hierarchy of knowledge ensured that each discipline perform functions specific to their domain. Value was attached to the hierarchy: lower sciences such as mathematics elicited their meaning from higher sciences. The Ancients and Scholastics cautioned against blurring the distinction between disciplines or requiring one discipline to do the work of another. In Book II of *Physics,* Aristotle warns against importing principles from other disciplines such as mathematics into the study of natural phenomena, seeing a correlation between clarity of distinction within disciplines and clarity within the disciplines themselves.

Five centuries after Aristotle, Ptolemy used mathematics to explain the pathways of heavenly bodies. Ptolemy's use of mathematical modelling to map eccentric and epicycle movement provided a platform for astronomers to calculate celestial motion without demanding a realistic justification or a physical proof of movement that was grounded in physical

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[486] Roger Ariew, "Christopher Clavius and the Classification of Sciences," *Synthese*, Vol. 83, No. 2, (May 1990): 293.

[487] Ernan McMullin, "Conceptions of Science in the Scientific Revolution" in *Reappraisals of the Scientific Revolution*. (Cambridge: CU Press, 2004), 28.

observation.[488] Eleven centuries later, at Oxford, Robert Grosseteste proposed a reordering of value for mathematics in demonstration and explanation of natural phenomena, stating that "only mathematics can provide the reason for subalternated science and even for natural philosophy."[489] Both Grosseteste and Roger Bacon agreed with the Ancients that the higher sciences elicited the reason for the lower sciences, but Grosseteste suggested that in the order of reality, the existence of a pure mathematical structure was *a priori* to physical reality provided the only adequate explanation of the natural world.[490] Bacon would further develop this view, adding that mathematics was antecedent to natural philosophy *and* metaphysics. Bacon also believed that science without mathematics was a deprivation, stating that "without mathematics no science can be had."[491]

Though contemporaneous with Grosseteste and Bacon, Albert the Great and Thomas Aquinas at the University of Paris opposed the mathematical realism of the Oxford school, maintaining that mathematics, physics and metaphysics were three radically different sciences that elicited and defined their content from the object of their study and their method. Mathematics considered quantified being and physics studied natural beings, while the object of metaphysics was being in itself. They supported the idea of the Ancients that within the hierarchy of knowledge, the higher sciences provided the reason for the lower sciences and were antecedent to the lower sciences. The higher sciences were incapable of deriving their principles from the lower sciences; physics, for example, could not elicit principles from mathematics or any of the middle sciences such as astronomy or optics.[492]

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[488] Annibale Fantoli, *Galileo, for Copernicanism and for the Church* (Cambridge: International Society for Science and Religion, 2007), 9.

[489] Quoted in Ariew, "Christopher Clavius and the Classification of Sciences," 294.

[490] William Wallace, *Einstein, Galileo and Aquinas: Three Views of Scientific Method* (Washington, D.C.: Thomist Press, 1963), 3.

[491] Ariew, "Christopher Clavius and the Classification of Sciences," 294.

[492] Ibid., 294.

Albert combined Aristotelian thought with observational and experimental natural philosophy but maintained that knowledge of reality was primarily physical. Mathematics could be used to *describe* physical reality and *assist* in providing certain proofs about the physical world, but mathematics in itself could not explain physical nature. Aquinas would add that mathematics assisted the physicist in the formation of hypotheses that suggested possible physical explanations and provided possible physical reasons as conclusive proof, but quantifications provided by mathematics were secondary because they were abstracted, making them superficial and more limited than physical or causal explanations.[493] Mathematical beings were intermediate – neither pure beings of reason nor real beings, but having features of both. Lines and circles existed in the real world, but they were not the same lines and circles studied by mathematics.

The abstract and discrete nature of mathematics caused a second deficit in the pursuit of certifiable knowledge for Albert and Aquinas. Mathematics, by its nature, trained the mind to consider one aspect of a thing while leaving out the consideration of other aspects that belong to that thing, making the consideration of the knowledge of the whole selective and incomplete. Mathematical concepts that were discrete in their consideration and did not conform to anything outside the construct of the mind were categorized as neither true nor false.[494] Things that were neither true nor false were intermediate beings that were possible or probable, but by their nature lacked sufficient proof. For Albert and Aquinas, mathematics provided an explanation for physical reality with the understanding that a distinction existed between *hypothetical explanation and proven fact*. A perfection that remained only in the human mind and did not necessarily correspond to physical reality lacked the wholeness and integrity of physical proof.[495]

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[493] Wallace, *Einstein, Galileo and Aquinas,* 4.

[494] Armand Maurer, "Thomas Aquinas on Mathematics; Thomists and Thomas Aquinas on the Foundation of Mathematics," *The Review of Metaphysics* Vol. 47, No. 1 (Sep. 1993): 56.

[495] Wallace, *Einstein, Galileo and Aquinas,* 5.

Thomas' explanation of the shape of the earth, for example, stated that the spherical shape of the earth could be proved by a mathematical proof of measurement across the surface of the earth. But *a more decisive way* to explain the spherical shape of the earth is to observe the uniform tendency of bodies to gravitate toward the earth's centre at the same angle. The more certain determination of shape of the earth is the observation of a uniform action of gravitational forces as part of its components. The shape of the earth is an imperfect sphere because of its irregular surface formed by mountains and valleys. In commenting on Ptolemy's eccentrics and epicycles, Aquinas supports the use of mathematics in describing the placement and movement of the stars, but limits the role of mathematics by making a distinction between theory and fact, allowing that another possible explanation may exist.[496]

When the mathematical sciences emerged in the mid-sixteenth century, the line between the natural world and the abstracted world, between hypothetical theory and proven fact, became less clear. Beyond that, the concept was reversed, and a new understanding of mathematics stated that not only did mathematics not limit certain knowledge of natural phenomena but provided a *more complete explanation* of the natural world.[497] Mathematics was not extrinsic to nature, it was embedded in nature. Mathematical models could reveal the framework and intelligibility of nature with certainty and provided explanations that penetrated beneath the level of the senses, which were fallible and could deceive. The abstractive quality of mathematics allowed for the construction of a truer depiction of the structure of the universe. In his preface to *De Revolutionibus,* Osiander categorized the work as an exercise which offered a hypothetical

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[496] Ibid., 5.

[497] Ofer Gal, Raz Chen-Morris, "Nature's drawing: problems and resolutions in the mathematization of motion" *Synthese*, Vol. 185, No. 3, (April 2012): 429.

treatment and saved the appearances.[498] In reality, Copernicus relied on the autonomy of mathematics rather than observable phenomena to formulate the theory of heliocentrism.[499] Advancements in technology demonstrated the inconsistencies of the Ancients and Scholastics and affirmed hypotheses confirmed by mathematical modelling. By 1610, Galileo was writing that "the book of nature is written in the language of mathematics, and the symbols are triangles, circles and other geometrical figures, without whose help it is impossible to comprehend a single word of it; without which one wanders in vain through a dark labyrinth."[500] In the *Dialogue,* he advanced a step further, stating that the pure mathematical sciences not only provide a true understanding of nature, but propositions that lacked definition by the Ancients could now be grasped with absolute certainty. He praised the "clever intellects" who had separated out the errors and fallacies upheld by a long tradition, and those left unquestioned by his contemporaries. Galileo praises those who not only acknowledge the inconsistencies of the Ancients but replace falsehoods with *truth* and *fact.* According to Galileo, only the present generation has achieved this perfection because of "clear-seeing minds" that are aided by experimentation and seen most evidently "in the case of the mathematical sciences." [501] Human wisdom acquired through the mathematical sciences, particularly "Geometry and Arithmetik" is placed on the same plane as divine understanding because of its absolute certainty. This human understanding of mathematician was on level with

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[498] Nicholas Copernicus, Paweł Czartoryski, ed. *Complete works [of] Nicholas Copernicus* (London: Macmillan, 1985), Preface, xvi.

[499] Robert Westman, "Competing Disciplines: The Copernicans and the Churches", in *The Scientific Revolution: The Essential Readings*, Marcus Hellyer, ed. (New Jersey: Blackwell Publishing, 2003), 80.

[500] Galilei, Galileo, and Stillman Drake. *Discoveries and Opinions of Galileo: Including The Starry Messenger (1610), Letter to the Grand Duchess Christina (1615), and Excerpts from Letters on Sunspots (1613), the Assayer (1623*). New York: Anchor Books, 1990, 238.

[501] Publisher's Preface to the Reader, *Galileo Galilei, Dialogue of Two World Systems, 1638*, Translated from the Italian and Latin into English by Henry Crew and Alfonso de Salvio. With an Introduction by Antonio Favaro (New York: Macmillan, 1914), xx.

divine understanding, although the mathematician acquires discursively what God knows in an instant. [502]

This shift in criteria for certain knowledge of the physical world is a reversal of the medieval view that the abstractive, discrete and theoretical nature of mathematics made it a less certain way of knowing. The medieval adherence to causality and a burden of proof that was rooted in physical reality when explaining the natural world became less and less compelling, as mathematical sciences progressed and the line between hypothetical explanation and physical proof became blurred. The effect that these changes had upon the order of knowledge was gradual but significant. Harold Cook notes that the Scientific Revolution occurred less in the details of a shift from natural philosophy to the mathematization of nature, but in the "reordering of intellectual values."[503] The criteria for certain knowledge that was characteristic of the Ancients and Scholastics for millennia: the knowledge of causes, of universals and perfection of the whole in natural philosophy, physics and cosmology was replaced by a new standard of certainty that was derived from hypothetical abstraction and pure reason. The separation of mathematics from natural philosophy created a reordering of its place in the hierarchy of knowledge and provided a new impetus for the mathematical sciences to advance independently.

For the Jesuits who were bound to maintain the traditional corpus of Aristotle and Aquinas while striving to be men who were "outstandingly erudite" in the mathematical sciences, the tension between the ancient and modern criteria for certain knowledge created a disjunction within the community. As the discipline of natural philosophy was being reordered and the traditional lines between the disciplines were blurred, the Jesuit new man of science whose vocation was the

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[502] Wallace, *Galileo and His Sources*, 303.

[503] Harold J. Cook, "Physic and Natural History in Seventeenth Century England," in *Revolution and Continuity: Essays in the History and Philosophy of Modern Science,* Peter Barker and Roger Ariew, eds, (Washington DC: CUA Press, 1991), 79.

pursuit of the mathematical sciences grappled with its role and application in lecture halls, texts and public discourse. [504] Clavius supported the theoretical framework of Ancient and Scholastic philosophy, used figures from antiquity such as Archimedes and Apollonius to illustrate the usefulness of mathematics and maintained silence in matters that appeared to contradict geocentrism. Clavius describes the mathematical disciplines as excellent in themselves because of their certainty but also due to the nobility of their object, a notion borrowed from the Ancients and Scholastics.[505] At the same time he consistently advocated that the certainty of mathematics fostered truth and rejected what was false [506] because of its abstraction from accidentals such as size and shape, which are separate from the essence of the thing.[507] In doing this, Clavius established that the standard for certitude was not in the ability to understand the whole of nature but in the *ability to solve problems*. In *De Mathematicis,* he describes mathematics as not only certain and useful, but necessary. He lists examples from antiquity where mathematics supplied practical solutions at critical moments in history. Clavius is careful to include disciplines outside mathematics and the new sciences to demonstrate the universal effectiveness of mathematics.[508] Clavius ballasts his message (particularly to his colleagues at the Collegio Romano) by referencing

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[504] Ibid., 79.

[505] "And if (as with Aristotle and his followers), the nobility of doctrine depends both from the dignity of the things [studied] and from the dignity bestowed by rational demonstration, what must be thought of the mathematical disciplines, which – to say nothing of the pre-eminence of the things they treat – have such solidity in their reasonings that they seem not so much to persuade as to compel by force." Christopher Clavius, *Prolegomena in Opera Mathematica Vol 1,* (Roma: Moguntiæ, 1611*), 5.*

[506] Ibid*.,5.*

[507] Frederick A. Homann, "Christopher Clavius and the Renaissance of Euclidean Geometry", *Archivum Historicum Societatis Iesu*; Jan 1, 1983; (52): 239.

[508] He includes poets, historians, political and military leaders, physicists, cosmologists, physicians, seamen and farmers. Christopher Clavius, *De Mathematicis, Monumenta Paedagogica Societatis Iesu* (1586), ed. Ladislaus Lukacs (Rome: Institutum Historicum Societatis Iesu, 1965), 109. Illae namque suppeditant atque exonunt poetis ortus occasusque syderum, historicis locorum facies atque intervalla; analyticis solidarum exempla demonstrationum, politicis artes plane admirabiles rerum bene gerendarum domi militiaeque; physicis coelestium conversionum, lucis, colorum, diaphanorum, sonorum formas et discrimina; metaphysicis sphaerarum atque intelligentiarum numerum; theologis praecipuas divini opificii partes; iuri et consuetudini ecclesiasticae accuratas temporum supputationes. Ut praetereantur interea, quae ex mathematicarum labore redundant in rempublicam utilitates in morborum curationibus, in navigationibus, in agricolarum studio. Conandum igitur est, ut sicut facultates caeterae, ita et mathematicae in nostris gymnasiis floreant…Trans. M. Looney.

the "authority of mathematical disciplines," a term that might have been confusing to his fellow Jesuits, as mathematics would have had limited authority at the time of his writing. His expression is an appeal to authoritative sources with the intention of bridging the ancient and modern criteria for certainty. At the same time, it leaves the reader questioning the kind of authority mathematics carried in relation to the associated sciences in the 1580s.

Continuing in the *Prolegomena*, Clavius cites the genius of Archimedes who found mathematics compelling by virtue of its rationality, usefulness and capacity for solving problems. Mathematics allowed the mind to perceive and understand, "so that it neither inclines to the more doubtful, nor sways, nor is it imbued with error."[509] Continuing in the fourth section, Clavius acknowledges Proclus' placement of mathematics as intermediate to physics and metaphysics in terms of abstraction, but ranks the mathematical sciences over metaphysics and natural philosophy because of their reliability and certainty, "so that they truly produce knowledge (scientia) in the mind of the hearer and remove completely all doubt."[510] In convincing his colleagues in the Society of the validity of mathematics, Clavius urges members in the Society to set aside their disagreement about the place of mathematics in the Society[511] and reproves his peers for failing to acknowledge the place of the mathematical sciences.

A careful look at what Clavius was *doing* in his texts indicates that he was not only able to live in both worlds, apparently at ease with the tension between the ancient and the new but that

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[509] Christopher Clavius, *Prolegomena in Opera Mathematica Vol 1,* (Roma: Moguntiæ, 1611*),* 15. Quotus enim quisque est, qui Archimedis, et Apollonii, caeterorumque Mathematicorum libros legens acutissimorum hominum non admiretur ingenia, et menti suae firmissimas quasdam quasi machinas admoveri non sentiat, ut iis quae illi tradunt, vel invitus assentlrl cogatur? Qua quidem ex re dici vix potest, quantam animus noster capiat voluptatem, dum ita in sententia perstat, remque omnem plane percipit, ac tenet, ut neutram in partem dubius inclinet, nusquam fluctuet, nedum falsis opinionibus imbuatur. Trans. M. Looney.

[510] Quoted in Homann, "Christopher Clavius and the Renaissance of Euclidean Geometry", 52.

[511] In *Modus quo disciplinae*, he encourages his colleagues to refrain from telling students that the "mathematical sciences are not sciences, do not have demonstrations, abstract from the being and the good, etc…," as a reprimand his fellow Jesuits who did not support the mathematics program within our outside the halls of the colleges. Cited from English Translation of *Modus quo disciplinae* in Wallace, *Galileo and His Sources*, 2014, 137.

he contributed to a disjunction by advocating that the mathematical sciences be regarded as an independent category, worthy of consideration for its own sake. In the *Prolegomena*, Clavius widens the breach by claiming the truth, purity, clarity and strong demonstrations mathematics were capable of clarifying doubtful things with absolute certainty.[512] Mathematical disciplines foster the truth and reject not only what is false but *whatever is merely probable*, lending support to the most certain demonstrations.[513] Here Clavius enters the territory of what Aquinas would call "intermediate being", something that was neither pure being of reason nor real but having features of both, and claims that mathematics is the very instrument by which an uncertain or probable term can be resolved. Clavius uses the Ancient and Scholastic burden of proof that the truth is found neither in probable or possible things but in what is either true or false, *and he uses mathematics to do it*. Mathematics is elevated above the other sciences because it eliminates those things that are suspended between what is true and what is false.

After the Trials

After decades of debate within the Society about the role and classification of the mathematical sciences, the tenacious objections of the natural philosophers gave way in the wake of the Galilean Trials. Within a few decades after the death of Clavius in 1612, a shift within the discipline of natural philosophy occurred that improbably fulfilled a prophesy uttered by Clavius years before. During Clavius' lifetime the Ancients' concepts of order in the universe and to a degree, the corpus of traditional natural philosophy were challenged by the plausibility of

[512] Clavius, *Prolegomena in Opera Mathematica Vol 1, 5.* Theoremata enim Euclidis, caeterorumque Mathematicorum, eandem hodie, quam ante tot annos, in scholis retinent veritatis puritatem, rerum certitudinem, demonstrationum robur, ac firmitatem …. Trans. M. Looney [italics mine].

[513] *Ibid., 5* Dubium esse non potest, quin eis primus locus inter alias scientias omnes fit concedendus. Trans. M. Looney.

heliocentrism. Up until the Galilean trails, professors of natural philosophy took several approaches to heliocentric theory; they avoided the question altogether, presented Copernican theory as a hypothesis among other logical hypotheses, or discussed it in the mode of a possibility or a theory that may eventually be substantiated. The lecture notes of the Jesuit Antonio Casilli indicate that during his tenure at the Collegio Romano from 1621-1631, in his discussions of the heavens, he avoided the topic of Copernicanism. Sforza Pallavicino's commentary on *De Caelo*, published in the early part of the seventeenth century treats the origin, perfection, accidents and influences of the heavens with detail but again refrains from comment on heliocentric theory.[514]

After Galileo's trial and 1633 condemnation, a notable shift takes place amongst the professors of natural philosophy at the Collegio Romano. The caution of previous generations to include of mathematics in the presentation of natural philosophy shifted to the incorporation of mathematics when explaining Copernicus' theory in lecture notes. Diagrams, illustrations and tables appear in lecture notes of professors of natural philosophy at the Collegio Romano. The purpose of their placement is not entirely clear. It is possible that lectures wished to explain a contemporary event or even to use mathematics to refute heliocentrism. What is clear is that natural philosophers who were previously resistant and even hostile to the incorporation of mathematics into natural philosophy began to use mathematics to enhance their teaching, relying in part on the formulae and methods developed by Clavius. The result was a mix of quasi-explication beginning with an Aristotelian ideal of eternity, corruptibility and perfection and ending with an explanation of the relative motion of earth within the celestial realm.[515] An illustration of this is Gabrielle Beati (d. 1673), a mathematics lecturer at the Collegio Romano who

[514] Renée J. Raphael, "Copernicanism in the Classroom: Jesuit Natural Philosophy and Mathematics after 1633", *Journal for the History of Astronomy* 2015, Vol. 46(4): 423.
[515] Ibid., 426.

made no notable contributions in the mathematical sciences and provoked no known controversies within the Society. His published commemorative texts on natural philosophy provide an insight into what a typical, uncontroversial view of the Jesuits at the Collegio Romano might have been in the mid seventeenth century.[516] Almost every plate in Beati's work is mathematical, including a middle foldout section that provides a synthesis of mathematical models for physical aspects of the cosmos. This shift took place almost immediately after the Galilean trails by professors who in a previous generation would resist any incorporation of mathematics to clarify cosmological concepts or other concepts associated with natural philosophy. Like Clavius, they would have met with challenges early on in incorporating the mathematical sciences into their disciplines while remaining rooted in the tradition of Greek and Scholastic science. Hybrid approaches would appear later, such as Riccioli's *Almagestum Novum* (1651), mentioned above in chapter five, which attempted to incorporate mathematical alternatives to Ptolemy and was groundbreaking for its time, but it too crumbled as new data emerged and displaced his model.

What is significant about this new approach is that the professors of natural philosophy employed a reverse incorporation of mathematics *into* philosophy to clarify and certify their explanations. Natural philosophers continued to use Scripture and natural arguments to discuss the pros and cons of planetary theory, but they expanded their sources to include mathematical systems that would explain topics in natural philosophy, as Clavius had recommended years before. One consequence of the shift was a blurred distinction, born partly out of necessity, between natural philosophy and mathematics. When Clavius directed the academy of mathematics at the Collegio Romano, mathematics and the mathematical sciences were the exclusive practice of his select corps who were trained by him, who rigorously defended his work and supported the

[516] Kerry V. Magruder, "Jesuit Science After Galileo: The Cosmology of Gabriele Beati", *Centaurus* 2009, (Vol. 51): 191.

practice of mathematics as an independent discipline. By the middle of the seventeenth century, professors of natural philosophy had dual positions in departments of philosophy *and* mathematics.[517]

Were these hybrid incorporations short term compromises or provisional gestures that awaited the inevitable incorporation of Copernicanism? Did the professors of natural philosophy incorporate Copernican theory into their teaching for the purpose of defending the Church in the wake of the outcome of the Galilean trials? What did the Jesuits stand to lose by remaining in the suspended territory of supposition? The generation of Jesuit mathematicians after Clavius continued his work by a process of moving from impossibility to improbability in a progression of degrees, using a plurality of models that were neither pure beings of reason nor real but having features of both. As Jesuit professors at the Collegio Roman dealt with Aristotle's' *De Caelo*, they expressed their teachings in terms of progressive possibility. In the absence of certainty, Jesuit cosmologists such as Marini and Riccioli presented hybrid solutions that combined Copernican and Ptolemaic systems that were labelled as "our system."[518] The challenges of Clavius' generation were reduced to an extrinsic probabilism in the second generation which employed a number of options that, in the absence of absolute certainty, had a chance of being the correct one. This process was accompanied by changes in content and organization in the syllabi and lecture notes of professors of mathematics and natural philosophy, as areas of the curriculum spilled over into other disciplines in reactive response to the Galilean Trials. The cosmology that Clavius taught while carefully avoiding alternate views of the universe became conflated in the next generation that followed.

[517] Raphael, "Copernicanism in the Classroom", 432.
[518] Ibid., 424.

Compelling advances made by the mathematical sciences overshadowed the traditional teachings of the Ancients and Scholastics. The Society's adherence to Aristotelian cosmology and natural philosophy was evolving, even as members of the Society were bound to maintain it. As the Scientific Revolution unfolded, a second disjunction occurred that flowed from the first. A separation occurred between the men within the academy and their internal and external audiences and the narratives they conveyed to each.

Audiences in Europe

A less obvious separation of the order of knowledge within the Society led to a more visible disjunction in the story of Clavius' academy between the intentions of Jesuit mathematicians and reception of their message amongst various audiences in Europe and *literati* on the missions. Clavius' core strategy included using mathematics and the mathematical sciences to influence the powerful, convince the sceptical, draw converts to the Church, confound the logic of those opposed to Catholicism and promote renewal of the Catholic faith in Europe and abroad. Elaborate ceremonies at the Collegio Romano and other colleges drew attention to mathematics and the new sciences. Public displays of the mathematical sciences heightened their prestige amongst members of the Society and in the eyes of the wider audience beyond the Collegio Romano, and reinforced the idea that academic colleges were the locus for committed and serious study of the mathematical sciences amidst a growing membership in European scientific societies.[519]

But the mathematical and scientific work of the academy was ultimately a work of evangelization. Among the European nations whose lands were torn by confessional strife, an air of suspicion about Clavius' motives lingered amongst advocates of the emerging sciences. The

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[519] David S. Lux, *Patronage and Royal Science in Seventeenth-Century France: The Academie De Physique in Caen* (Ithaca, NY: Cornell University Press, 2019), 39.

result was a disconnection within the European scientific community, who often interpreted the Jesuits' involvement in the mathematical sciences as a veiled form of proselytization. The Jesuits' international network of communication regularly supplied information about natural curiosities and new scientific discoveries in the mathematical sciences. It also provided a conduit for the latest mathematical and technological exchanges. Their exclusion from membership in scientific societies and a general mistrust of their motives limited the Jesuits' ability to directly influence the development of the mathematical sciences in Europe.

Many Jesuits, beginning with Clavius, enjoyed a cooperative working relationship with some of the leading mathematicians and scientists of the sixteenth century. The Jesuits' correspondence with Kepler, Brahe, Mersenne and Galileo attest to a regular exchange of knowledge. Galileo, as William Wallace demonstrates, borrowed lecture notes from the Jesuit lecturers at the Collegio Romano in preparation for his work in Pisa. Collaboration, albeit in some cases limited, was beyond the influence of scientific societies and spanned across generations of Jesuits.

Here a separation unfolds that was begun in Clavius' time but manifest in the generation that followed. As adherence to an Aristotelian cosmology was stressed within the Society and superiors repeatedly reminded members to maintain orthodoxy in their lectures and publications, relations with key individuals began to unravel. Some mathematical scientists in Europe distanced themselves from the Jesuits, as Galileo did as he became more convinced of his position after the discovery of the phases of Venus. Between the trials and after the death of Clavius, he separated himself even from men like Grienberger who publicly supported his work. After the second trial, Galileo wrote an embittered letter to the Jesuit educated Nicolas Claude Fabri de Peiresc (d. 1637), complaining about the Jesuits, and stating that he harbored ill feelings against the men of the Society who were now using their power and influence to impede the progress of his publications:

> Having discovered many fallacies in the philosophies commonly taught in the schools now for many centuries and having communicated some of them and also published some, I have aroused such animus in the minds of those who want themselves alone to be known as learned that, because they are very crafty and powerful, they have known how and been able to grasp the means to suppress what I have found and published and to impede my publication of what remains with me.[520]

The confluence of events surrounding the Galilean trials impacted what was previously a congenial relationship between the Jesuits and Galileo. In this instance, Galileo's convictions about the veracity of the mathematical sciences against a questionable knowledge of Ancient and Scholastic natural philosophy caused him to distance himself from the Jesuits. The Society's dual commitment to the realms of science and religion, coupled with his ecclesiastical reprimand caused Galileo to recast them as enemies who used their influence to prevent his work from progressing.

Ecclesial Audiences

A second example of the separation between intentions and perception occurred between the men of the mathematics academy and Church officials occurred as the priest-mathematicians carried out their work on the missions. As mentioned in chapter seven, a document, *Instructiones ad munera apostolica rite obeunda*, was issued through the office of the Congregation for the Propagation of the Faith that cautioned the Jesuit missionaries that they ought to be of good repute so that their message could be heard, warning that those who cultivated the sciences and the arts

[520] Richard S. Westfall, *Essays on the Trial of Galileo* (Vatican City State: Libreria Editrice Vaticana, 1989), 50. See also: Drake, Stillman, and Galileo Galilei. "Galileo Gleanings XII: An Unpublished Letter of Galileo to Peiresc." *Isis* 53, no. 2 (1962): 209.

and were regarded as "ingenious and learned" risked the misunderstanding of being considered "cunning" men." For missionaries like Ricci, their secular responsibilities were a compliment rather than an obstacle to their spiritual mission; moreover, the mathematical sciences were a bridge and a shelter to be used when the missionaries could not speak openly about religious matters in public. Science served as a cloak for religion (to use Verbiest's phrase). In addition, it assisted the Jesuits in securing influential positions at the Imperial court, which Ricci believed, would bolster their credibility as religious men.

Sixty years before the visitation to the missions, Father General Aquaviva wrote a general letter to the men of the Society that acknowledged the risks of deep immersion in secular affairs. He observed a separation emerging between the intention of the men who were "going in by their door to come out of our door"[521] and the public response. Aquaviva prefaces his remarks by stating that people are saying the men of the Society were "getting too mixed up in secular affairs . . . having too much to do with the people of the world . . . being too free in our doctrine and too fond of novelty, self-interested and avaricious, jealous of our honour and our public reputations…." [522] Yet three years later, Ricci wrote to Rome pleading for new books in mathematics and the sciences, claiming that new text translations "would give us great face, would open wider the gates of China, and would enable us to live more securely and freely."[523] Mathematics provided a universal language that enabled them to transcend linguistic differences and to navigate the polarisation that was brought about by differences of politics or religion.

[521] Ignatius Loyola to Fathers Salmeron and Broet, Rome 1545, *in Letters of St. Ignatius of Loyola,* ed. William John Young (Chicago: Loyola University Press, 1959), 51.

[522] Claudio Aquaviva to the members of the Society, 29 July 1602. Philippe Lecrivain, "Charity in Union of Hearts: A hermeneutical exploration of the Acquaviva period", *Review of Ignatian Spirituality*, xxix, iii (1998). www.sjweb.info/documents/cis/pdfenglish/199808906en.pdf

[523] Matteo Ricci to General Alvarez, Peking, 12 May 1605, Venturi, *Opere Storiche,* 285.

Audiences on the missions

The Jesuits' decision to immerse themselves in the mathematical sciences in order to wield influence in religious matters evoked criticism from secular voices and ecclesial officials as they questioned the reception of their mathematical message on the missions. Chapters seven and eight discussed a third effect that took place on the mission territories, as a separation emerged between the men of the Society and their audiences. Several assumptions on the part of the missionaries may have contributed to their ability to function freely as priest mathematicians.

The first assumption was that Western science was more advanced than the science that was developing in the countries to which they were being sent on mission. The insistence of Ricci and his companions that the latest translations of mathematical texts be sent shows their confidence in European mathematics and its ability to leverage credibility on the missions. Journal accounts attest that in some cases the mathematical sciences that were brought from Europe were received favorably. In other instances, skepticism remained, or the audience showed a lack of understanding or appreciation for the efforts of the missionaries. As previously noted, the Chinese model of equatorial, polar cosmology that existed before an encounter with European missionaries was more accurate and advanced than the model of Aristotelian crystalline spheres brought by the Jesuits. The Jesuits' confidence in the superiority of Western science can be seen in their response to challenges from members of the host culture: when Yi, a Korean cosmologist questioned Aristotle's immutable concept of the heavens, the Jesuit Rodrigues responded that the Chinese astronomers had erred in their calculation of the ephemerides.[524]

A second assumption was that audiences on the missions would be enamored of the mathematical sciences and technological advancements brought to them by the Jesuits and that

[524] Donald L. Baker, "Jesuit Science through Korean Eyes," *The Journal of Korean Studies*, Vol. 4 (1982-83): 207.

this would secure their credibility. “Because of my world-map, my clocks, spheres and astrolabes and the other things I do and teach, I have gained the reputation of being the greatest mathematician in the world,”[525] Ricci wrote. But Rodrigues’ gift of a clock to the Chinese diplomat spurred universal laughter and the telescope was used for enemy reconnaissance rather than celestial observations. The Jesuits arrived on Asian shores with texts, calendars, tables, astrolabes, maps, clocks and telescopes, and attracted the attention of the Imperial court and astronomers by the novelty and usefulness of technology. As their identity shifted from mathematician to priest, audiences were unable or unwilling to make the same shift. Instead of referring to them as Catholics or priests, they were nicknamed “the mathematicians.”[526]

A final assumption on the part of the Jesuit missionaries was that after having accepted the superiority of Western science and the credibility of the priest mathematicians, their audiences would naturally transfer confidence in the noble doctrine of the mathematical sciences to the truths of religious doctrine. In accepting mathematics, potential converts would naturally be led to belief in Christianity. In some cases, this did happen, but in many instances the presentation of religion so closely resembled Confucianism that native audiences saw no distinction between the two. Ricci’s once eager Christian disciples returned to the practice of Confucianism[527] but kept the books, astrolabes and maps. In the case of Ricci’s maps in Japan, the maps were considered to be credible once the references to Christianity were removed. As with Galileo, audiences initially distanced themselves from the mathematical missionaries. With time, they were seen as impostors

[525] Matteo Ricci to General Alvarez, Peking, 12 May 1605, Venturi, *Opere Storiche,* 284-285.

[526] Barbara Widenor-Maggs, “The Jesuits in China”: Views of an Eighteenth-Century Russian Observer,” *Eighteenth-Century Studies* 8 (Winter, 1974-1975): 447.

[527] Catherine Jami, “Western Mathematics in China, Seventeenth Century and Nineteenth Century” in *The Scientific Aspects of European Expansion*, William K Storey, ed., (Aldershot, GB: Ashgate Pub. Co. 1996), 307.

or even enemies. Eventually, the Chinese disregarded the Christian teachings altogether and placed Ricci's religious writings on the Chinese "index" of forbidden books.

Response from superiors

The first Jesuits were steeped in a tradition of Aristotelian philosophy, Roman humanism and Thomistic theology as standard sources for the formation of the men in the Society and for the students in their schools. As men from the Society extended the boundaries of exploration and experimented with alternate approaches, superiors of the Society encouraged innovation and creative evangelization. At the same time, they emphatically reinforced adherence to the Ancients and Scholastics in teaching and publications. Towards the beginning of the seventeenth century the tone hardened, and penalties were attached to those who refused to comply. The absence of a unified philosophical understanding that was universally accepted by the members of the Society led to a disparity between a message that was communicated internally to members of the Society and what was expressed publicly. Practical application varied widely amongst members of the Society, in their communications with one another and with colleagues outside the Society, in lecture halls and on the missions. This disparity is reflected in the final version of the *Ratio Studiorum*, which after nearly thirty years in draft was reduced to a handbook of administrative procedures, position descriptions, book inventories and discipline codes. The promulgation of the *Ratio* was met with resistance amongst members of the Society.

The Jesuits carried out their religious mission in obedience to their superiors, under difficult circumstances that were exacerbated by the fact that the data led priest mathematicians of the Society to adhere to the increasingly compelling evidence provided by the mathematical sciences. Rather than sound a retreat and return to the traditional methods of evangelization, the priest-mathematicians pursued mathematics and the new sciences with increased vigor, as a means of religious conversion, as the two worlds in which the Jesuits were heavily invested were drifting apart in the late sixteenth century. The challenging cultural, social and religious circumstances in which they were founded coupled with the ambition to embrace both sacred and secular, created a wider disjunction within the Society and a separation of narratives within and outside the Society.

Conclusion

The Society's natural philosophers incorporated mathematics into their lecture notes on cosmology after the Galilean trials. Clavius' approach and that of his proteges and of the natural philosophers in the Society demonstrates this was not a static reality, but a movement that took place in response to evolving events in the wider culture, within the context of the emerging mathematical sciences and the post Reformation Catholic Church. The core challenge for the Jesuits was a shift in the understanding of the limits and demands of proof and plausibility. The Scholastics believed that suppositions that were formed in the physical sciences were derived from their unique realm of experience, and the certitude of their conclusion could be validated, but only within the context of their unique discipline.[528] Galileo advanced the idea that the absolute power of mathematics provided certainty and truth *a priori* and was, by its purity, of greater value than physical knowledge and physical proof. The intelligibility of nature was most assured by mathematics, and he employed effect-to-cause reasoning to unmask the mystery and reveal the real, underlying structure of the universe.[529] Clavius, adhering to the tradition, relied on observational claims, physical demonstrations and biblical passages to carry out his science.

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[528] William A. Wallace, *Einstein, Galileo and Aquinas: Three Views of Scientific Method* (Washington, D.C.: Thomist Press, 1963), 20.

[529] William A. Wallace, *Galileo, the Jesuits and the Medieval Aristotle* (Hampshire, UK: Variorum, 1991), 112.

This disjunction illumines, in part, the challenge that the second generation of Jesuits faced as they carried forth Clavius vision as mathematical missionaries. From the viewpoint of the Ancients and the Scholastics, the use of an intermediate entity that was neither pure reason or real being that is abstractive in nature was only representative of the whole, selective and incomplete, and lacked direct conformity to anything outside the mind. In the blurring of the natural and abstracted world, the line between hypothesis and fact also became blurred along with causal connections that were necessary for proof. As an early Jesuit, Clavius was compelled to promote the mathematical science, but always in relation to natural philosophy. The generation of Jesuits that followed were less compelled to do so.[530]

The result was an internal separation within the community and a weakened credibility amongst audiences outside the community. The ultimate purpose of the mathematics academy, to draw others to Christianity, distanced the members of the Society from European scientific circles. Church authorities questioned the use of mathematics and mathematical sciences to convey religious truth prior to using tradition ways of introducing Christianity. On the missions, the priest mathematicians were met with an initial enthusiasm followed by suspicion and rejection of the Jesuits and the faith they sought to impart.

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[530] Raphael, "Copernicanism in the Classroom", 432.

Conclusion

The mathematical sciences provided a portal for the Jesuits that allowed them access to people and places that might have otherwise avoided the Society and their message. Rather than removing themselves from conflict that could potentially arise from combining religious orthodoxy with innovative strategies, the Jesuits positioned themselves squarely between these two worlds. As part of a vanguard movement in the Catholic Reformation, they established themselves as authoritative in matters of the Catholic faith and the mathematical sciences at a moment when authority, knowledge and belief in theology and natural philosophy were under critical re-evaluation.

Cultural and the religious changes in the sixteenth and seventeenth centuries created unique challenges for the Jesuits, who as priests and practitioners of the new sciences, were invested in both realms. These two worlds in which the Jesuits were engaged were drifting apart in the late sixteenth century. The challenging cultural, social and religious circumstances in which they were founded, coupled with an ambition to be completely invested in both the sacred and secular realms created a separation within the Society that mirrored an age marked by the Reformations and Copernican theory.

As priests and mathematicians, the Jesuits dedicated themselves to intentionally forming men who would be expert in both theology and the mathematical sciences, and even extending the limits of commitment to a total investment in the host culture. They did this to secure credibility and the confidence of those they hoped to draw towards religious conversion. When faced with difficulties, the priest-mathematicians pursued mathematics and the new sciences with increased vigor. Rather than sound a retreat and return to the traditional methods of evangelization, they remained within their religious tradition while embracing the mathematical sciences, to further the cause of religion.

Christopher Clavius' involvement in the Gregorian reform of the calendar secured his reputation as a skilled mathematician. During the fifty years that followed, he wielded a degree of influence within the Society and at the Collegio Romano, instituting a mathematics academy that trained the priests of the Society to be mathematical missionaries in Europe and in remote parts of the world. The international network of correspondence among Jesuits created a constant flow of scientific knowledge within the community. Clavius' students were zealous promoters of the mathematical sciences and adapted his curricula and texts to a wide variety of cultures and capacities.

Throughout his lifetime, Clavius maintained a neutral stance with regard to developments in the new sciences that could potentially create tension within his religious tradition. Clavius and his early companions approached the problem by remaining firmly positioned between the two worlds and advancing a position that mathematics was useful and necessary. The second generation of priest mathematicians struggled to maintain a hybrid position between traditional natural philosophy and the mathematical sciences. Those that followed after were challenged to maintain a unified narrative within and outside the community, but continued to develop the mathematical sciences by a variety of methods, even as the Society's leaders continued to call for a renewed adherence to the traditional teachings of Aristotle and Aquinas.

The lack of proportionate technology required to verify or discount hypothetical propositions created a place for mathematical abstraction in the Early Modern mathematical sciences. An emphasis was placed upon what was probable and was led by a series of mental constructions to conclusions that resembled what was true. This approach marked a clear break from the burden of proof required by the Ancients and Scholastics, who understood the absence of universality in mathematics and its reliance upon abstractive thought to be useful in the descriptive sense but deficit when drawing conclusions.[531]

The challenge faced by the Jesuits was not only navigating a clear course in a turbulent century. The difficulties of their age were exacerbated by the use of a medium that was built upon abstraction and hypothetical proposals to communicate with certainty the unchanging tenets of faith. The emerging authority of the new sciences cast a shadow upon traditional natural philosophy and as the Society of Antiquaries claimed, "[To] separate falsehood from truth and tradition from evidence … [by means of] the sagacity of modern criticism, in an age wherein every part of science is advancing to perfection . . . ."[532] The story of Clavius and his mathematics academy highlights his idealism but also the idealism of his age. Clavius was convinced that that reasonable men of any age, culture or state of life could be drawn to the truths of Christianity if they were first convinced of the truths of mathematics and the new sciences.

Clavius' story and that of the early Jesuits also illustrates the inherent challenges of a Jesuit priest-mathematician at the dawn of the Copernican revolution. The success of Clavius' academy did initially engender confidence in the Catholic Church and the Society, and the novelty of the new sciences drew the secular world toward the Society and even secured some converts to the

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[531] Robert A Maryks, *From Medieval Tutiorism to Modern Probabilism: "Spoils of Egypt" and the making of the Jesuit Conscience from Loyola to Pascal. Dissertation, Fordham University, New York. December 2005,* 107.

[532] Taken from the 1572 Charter of the Society of Antiquaries in *Archaeologia,* London, Vol. 1 (1770). Quoted in Silvio A. Bedini, "The Evolution of Science Museums." *Technology and Culture* 6, no. 1 (1965), 9.

faith. The exchange of traditional methods carried a risk that the Jesuits were willing to take. Ultimately, however, the credibility they wished to secure was compromised and their motives were misunderstood. The Jesuits' efforts to secure for themselves credible authority through the use of mathematics and the new sciences created a separation within the Jesuit community and among the wider Catholic communities they served.

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