Impotent Numbers: Korean Confucian Reactions to Jesuit Mathematics

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A couple of recent publications in Korea have driven more nails in the coffin of a long academically discredited assumption that, unfortunately, is still widely accepted among the general population in Korea. It is not unusual to read or hear in Korea that most Confucians during the latter half of the Chosŏn dynasty were so narrow-minded and hidebound that they were unwilling and unable to entertain any ideas and practices that were not sanctioned by centuries of Chinese Confucian tradition. Hong Sŏnp'yo and Ku Manok have shown conclusively to the contrary that books by European missionaries introducing Western mathematical techniques that appeared in China after 1600 were eagerly read by a wide-range of Korean Confucian scholars, and that most of those Confucian readers recognized the superiority of the techniques taught in those books.[1] Moreover, another Korean scholar has recently confirmed what has long been known by historians of science in Korea, that the official calendar for the last two centuries of the Chosŏn dynasty was based on European methods of calendrical calculation, and that Koreans knew those methods were European in origin.[2] There is therefore no justification for asserting that Korean Confucians rejected "Western Learning" (Sŏhak) in its entirety because of its non-Confucian European origins.

However, when we look at the long list of names of Chosŏn dynasty Koreans who studied Western mathematics, we find very little overlap with a list of names of Chosŏn dynasty Koreans who were attracted to another side of "Western Learning," the Catholicism those who wrote those mathematics texts came to China to preach. None of the famous mathematicians discussed by Chang Hyewŏn, such as Hong Chŏngha (1684--?), Ch'oe Sŏkchŏng (1646-1725), and Hwang Yunsŏk (1719-1791), played any role in the emergence of a Catholic community on the Korean peninsula. Ku Manok discusses a

[1] Chang Hyewŏn, *Sanhaksŏro ponŭn Chosŏn suhak* [Mathematics in Chosŏn Korea, as seen in mathematical publications.] (Seoul: Kyŏngmunsa, 2006); Ku Manok, "Mat'aeo Lich'i ihu Sŏyang suhak-e taehan Chosŏn chisigin ŭi panŭng" [The response of the educated class to the Western mathematics of Matteo Ricci],*Han'guk sirhak yŏn'gu* 20 (2010), pp. 301-355.

[2] Kang Yŏngsim, "17-seigi Sŏyang Ch'ŏnmun yŏkpŏp sŏjŏk ŭi suip kwa ch'ŏnmun yŏkpŏp insik ŭi pyŏnhwa: Sŏyang yŏkpŏbin sihŏngryŏk suyongŭl chungsimŭro" [The introduction of Western books on astronomy and calendrical calculation in the 17th century and changes in understanding of astronomy and calendrical calculation: focusing on the acceptance of the Sihŏn calendar, which was based on Western methods of calendrical calculation], in Hong Sŏnp'yo, *17.18 seigi Chosŏn ŭi waeguk sŏjŏk suyong kwa toksŏ munhwa* [The acceptance of Western-authored book in Korea in the seventeenth and eighteenth centuries, and the culture of reading] (Seoul: Hyean Publishing, 2005), pp. 221-263

broader group, including those who were not primarily mathematicians but included mathematics among the many subjects they included in their Confucian scholarship. A few of those Ku discusses, such as Yi Pyŏk (1754-17860, Chŏng Yakchŏn (1758-1816), Chŏng Yakchong (1762-1836), Yi Sŭnghun (1756-1801), Yi Sŭnghun (1756-1801) and Yi Kahwan (1742-1801), are associated with the founding of a Korean Catholic Church. However, most of those Ku discusses, such as Hong Daeyong (1731-1783), Pak Chiwŏn (1737-1805), Sŏ Hosu (1736-1799) and Hong Yanghae (?—1778)), stuck with mathematics only and were not the least bit interested in the religious beliefs of the Jesuit mathematicians in China.

At first glance, this is somewhat puzzling, since recent scholarship published on the other side of the Pacific Ocean, in North America, has confirmed what both academics and the general public have long known, that the Jesuit missionaries who traveled to China in the 17th and 18th centuries and wrote books introducing Western science, technology, and philosophy to the Confucian world did so for one reason and one reason only---to convert Confucians to Christianity.[3] Both Florence Hsia and Liam Brockey draw solely on European-language sources, so they don't have much to say about how people in China, Korea, and Japan responded to the Jesuit missionary drive. However, they both make clear, from their reading of what Jesuits themselves were saying about their reasons for traveling to East Asia, that mathematics, science, and technology were nothing more than tools to be utilized in their proselytizing project.

Hsia highlights the Jesuit subordination of mathematics to religion in some of the subheadings in her chapters. Sub-headings such as "the missionary mathematician" (p. 21), "the mathematician as saint" (p. 26), "the mathematician as martyr" (p. 30) and "mathematical magic" (p. 45) are used to draw her readers' attention to the relationship the Jesuits themselves saw between their mathematical skills and their proselytizing goals. She also points out, however, that the vast majority of Jesuits missionaries in late Ming and Qing China focused almost exclusively on either converting Chinese to Catholicism or ministering to those already converted. "As for the more than four hundred individuals who bore the burden of the old Society's evangelical efforts in the Middle Kingdom…only a bare handful—perhaps fifteen in all—ever held positions in the imperial Astronomical Bureau." She notes that a few more may have spent some of the time "casting astronomical instruments, surveying landscapes, or rendering texts in natural philosophy, pure and mixed mathematics, and medicine," but they still didn't amount to more than 20% of the total number of those who toiled in the Jesuits' China mission.[4]

Brockey provides an even more persuasive depiction of the Jesuit missionaries as more concerned with matters of faith than of mathematics or science. He shows in his survey of

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[3] Florence C. Hsia, *Sojourners in a Strange Land: Jesuits and their Scientific Missions in Late Imperial China* (Chicago: University of Chicago Press, 2009); Brockey, Liam Matthew, *Journey to the East: The Jesuit Mission to China, 1579-1724* (Cambridge, MA: Harvard University Press, 2007).
[4] Hsia, p. 5

Jesuits activities in China in the 17th and 18th centuries that most of those missionaries were more interesting in the ritual life of their flock than in the mathematics they used. And he also points out that most Chinese Christians shared their priests' emphasis on religion over secular knowledge. "The vast majority of Chinese Christians had little interest in the Western science and technology that the missionaries used to win friendships among the educated elite."[5] He also notes that the elite of China were able to separate Jesuit mathematics and science, which was acceptable, from Jesuit religious beliefs and practices, which were not. That became especially clear in the persecutions that broke out occasionally over the course of the 18th century, when the Jesuits working as astronomers and mathematicians for the court in Beijing were allowed to stay in China even though they fellow Jesuits were expelled from the country.[6]

Koreans, also, were able to separate Jesuit religion and Jesuit mathematics and science. Very few of the small number of Koreans who were Roman Catholics from 1784, the year the Korean Catholic Church was born, to the end of the 19th century were particularly interested in Jesuit writings on mathematics and natural philosophy. Moreover, as we have already noted, government officials in Korea were also able to separate Jesuit approaches to the natural world from Jesuit approaches to the supernatural realm, though in their case, they showed a much more positive reaction to Western mathematics and technology than they did to Catholic doctrines and ritual. Not only were they willing to use Western mathematical techniques for calendrical calculation, in the late 18th century they also used Western technology, such as pulleys and cranes, to construct the walls for what was supposed to be the new capital of Korea in Hwasŏng, present-day Suwŏn. However, at the same time, they persecuted Catholics who insisted on following Catholic rather than Confucian ritual procedures.[7]

Jesuit Mathematics and the Origins of the Korean Catholic Church

The Jesuit use of mathematics to entice Confucians into the Catholic Church was not a complete failure in Korea. Some of the founders of the Korean Catholic community were originally drawn to Jesuit publications because of their curiosity about the mathematics and science they taught. However, those who became and remained devout Catholics generally lost interest in mathematics and instead focused their attention on devotional and doctrinal writings, while those who remained interested in Western mathematics and science tended to distance themselves from Catholicism, especially when it became an object of server government persecution.

For example, Yi Sŭnghun, the first baptized Catholic in Korea that we know of, was able to travel to Beijing in 1873 when his father was appointed to a diplomatic mission to that Chinese capital. Before he left Korea, his friend Yi Pyŏk suggested that he stop by a Catholic Church in Beijing. "The Western missionaries will certainly be pleased to see

[5] Brockey, p. 216.
[6] Brockey, pp. 198-200.
[7] Peter H. Lee, ed., *Sourcebook of Korean Civilization* (New York: Columbia University Press, 1996), pp. 104-106, 109-159.

and will treat you well. Then you will be able to get a lot of interesting and enjoyable things from them. You must not come back empty handed."[8] Yi followed his friend's suggestion and sought out the European priests in Beijing.[9] He confessed later that he had originally approached them out of a desire to learn more about Western mathematics.[10] However, he said, he came to realize, from readings the books those priests gave him, that Catholicism was a "sacred teaching." Yi was baptized, taking the Catholic name Peter, and, after he returned to Korea in early 1784, became the primary organizer of a Korea's first Catholic community.[11] For the rest of his life, until he was executed in 1801 for his Catholic activities, he oscillated between acting as an ardent Catholic and hiding his faith to avoid persecution. However, he never became known for any particular expertise or even interest in Western mathematics, science, or technology. He is known only for his involvement with the Catholic religion in Korea.

When he was baptized in Beijing, the priests there gave him copies of Ricci's catechism, the Tianzhu shiyi [The True Meaning of the Lord of Heaven], along with two works on Western mathematics books. One was the Jihe yuanben [Elements of Geometry]- and the other was the Yuzhi Shuli jingyun [Imperially Commissioned Collected Basic Principles of Mathematics].[12] Shortly after he returned from Beijing, Yi Sŭnghun met with Yi Pyŏk and shared with him some of the books he acquired there. Yi Pyŏk, in turn, shared those

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[8] Hwang Sayŏng. Hwang Sayŏng paeks[The silk letter of Hwang Sayŏng], edited and translated by Yun Chaeyŏng (Seoul: Chŏngŭmsa, 1975), pp. 54-55 (lines 43-44)

[9] He was not the first Korean visitor to Beijing to take advantage of his time there to check out the exotic Western churches there. However, he was the first to return home a baptized Catholic. See Shin Ik-Cheol, "The Experiences of Visiting Catholic Churches in Beijing and The Recognition of Western Learning Reflected in the Journals of Travel to Beijing," *Review of Korean Studies*, 9:4 (December, 2006), pp. 11-31.

[10] See Yi's letter to the Catholic priests in Beijing, written in 1789. "Yi Sŭnghun kwangye woegugŏ sŏhan charyo" [Letters in a foreign language about Yi Sŭnghun], *Kyohoesa yŏn'gu*, vo. 8 (1992), p. 206. Also see Yun Min'gu, tr., *Han'guk ch'ogi kyohoe-e kwanhan kyohwangch'ŏng charyo moŭmjip* [Collection of Vatican Documents related to the Early Korean Church] (Seoul: Kat'ollik ch'ulp'ansa, 2000), pp. 164-65.

[11] Ch'oe Sŏgu, "Han'guk kyohoe ŭi ch'angsŏl kwa ch'och'anggi Yi Sŭnghun ŭi kyohoe hwaldong" [The founding of the Korean Catholic Church and the Catholic activities of Yi Sŭnghun in the early stages], Kyohoesa yŏn'gu 8 (1992), 10-12.

[12] Cha Kijin, "Manch'ŏn Yi Sŭnghun ŭi kyohoe hwaldong kwa chŏngch'ijŏk ipchi" [Manch'ŏn Yi Sŭnghun's political stance and his activities for the church], *Kyohoesa yŏn'gu***,** 8 (1992), p. 39.

books with some of his brothers-in-law, Chŏng Yakchŏn and Chŏng Yakchong. According to Chŏng Yakchong, Yakchŏn was very happy to learn about such books and to acquire the knowledge they contained. Howver, according to his brother, he didn't actually become a Catholic because of those books.[13]

Another Confucian who was interested in Western mathematics and was associated with the group of scholars who founded the Korean Catholic church was Yi Kahwan. According to one Catholic sources, Yi Kahwan "was well-versed in the study of astronomy and geometry. He used to sigh and say, "When this old man dies, that will be the end of geometry in this Eastern Country."[14] Yi was accused several times of being a Catholic himself and died from wounds suffered under interrogation during the anti-Catholic persecution of 1801. However, the charge that he was a Catholic appears unfounded. In fact, Yi appears to have drawn a clear distinction between the Western mathematics and Western religion, even though he realized others blurred the difference between them.

According to Chŏng Yagyong's epitaph for Yi Kahwan, Yi once declined a request from the king that he read some Jesuit books and write up a summary about the main points they make related to mathematics and calendrical calculation. Yi justified his refusal by explaining that there were a lot of ignorant people who could not distinguish the secular material in those books from religious material and he was afraid he would be face criticism for promoting Catholicism if he did as the king asked. The king accepted his excuse.[15]

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[13] "Sŏnjungssi myojimyŏng" [An epitaph for my brother Chŏng Yakchŏn], Chŏng Yagyong, *Yŏyudang chŏnsŏ* [The complete works of Chŏng Yagyong], I, vol 15, 39b. Later in his life Yagyong added an appendix to the epitaph for his brother in which he admitted that the books that both he and his brother got most excited about at that time dealt with such subjects as creation, life and death, and the difference between material and spiritual beings. He also admits that at first they were both quite attracted to Catholicism, but says that attraction ended when they learned of the Catholic prohibition of Confucian-style ancestor memorial services. (ibid, 42a)

[14] *Silk Letter*, line 46 (p. 56-57). For more on Yi Kahwan and Western mathematics and calendrical science, see Ch'oe Sangch'ŏn, "Yi Kahwan kwa Sŏhak" [Yi Kahwan and Western Learning], Han'guk Ch'ŏnjugyohoe ch'angsŏl ibaekchunyŏn kinyŏm Han'guk kyohoesa nonmunjip kanhaeng wiwŏnhoe, ed. *Han'guk kyohoesa nonmunjp: Han'guk Ch'ŏnjugyohoe ch'angsŏl ibaekchunyŏn kinyŏm, II* [A collection of articles on the History of the Catholic Church in Korea in commemoration of the 200th anniversary of the founding of the Korean Catholic Church vol. II] (Seoul: Han'guk Ch'ŏnju kyohoesa yŏn'guso,1985), pp.41-67

[15] Chŏnghŏn myojimyŏng" {An epitaph for Yi Kahwan], *Yŏyudang chŏnsŏ,* I, vol 15, 23a.

Chŏng Yagyong himself confessed to his king that he had been attracted to "Western Learning" when he was a naïve youth but had soon learned that Catholicism was an evil religion. He is what he told his king in 1797, when he resigned a post in the capital in order to get out of the line of fire of an anti-Catholic faction:

"When I read Catholic writings, I was still a young man, barely out of my teens. Reading books by Europeans was the popular thing to do at that time. Those books contained a lot of interesting information about astronomy and calendrical science, and about agricultural and irrigation technology. They also included some mathematical techniques useful for surveying land and calculating how large a harvest might be. We all read those books back then and talked about them among ourselves in order to gain a reputation for being well informed and well-read.

As I was still young, all I really cared about was having others think that I was a bright as the best of them. That is why I joined the crowd that was reading such books and talking about them. Unfortunately, by nature I am impatient and careless, so I just skimmed through those books without taking the time to understand their fine points and difficult passages. That is why I didn't recognize the flaws in those writings back then. On the contrary, I was entranced by their promises of life after death and was impressed by their calls for rigorous self-discipline. The twists and turns of their fancy rhetoric fooled me into thinking that what they were offering was just another form of Confucianism.[16]

The Confucian Encounter with Western Mathematics

The ability of Koreans Confucians to extract what they found valuable in Western mathematics and throw away the rest frustrated the Jesuit strategy for presenting "Western Learning" as an integrated whole that had to be accepted in its entirely or not at all. The Jesuits had not counted on Confucians in China and Korea being able to deconstruct even mathematics alone into three different features. Those three features are 1) the formulae, especially geometric formulae; 2) the method of calculating on paper with symbols for numbers instead of representations of counting rods, and 3) the notion of proofs.

The Jesuits introduced quite a few new formulae and mathematical and calendrical concepts which Confucians had little trouble accepting. "New algebraic notions (of Hindu-Arabic origins), Tyconic cosmology, Euclidean geometry, spherical trigonometry, and arithmetic and trigonometric logarithims"[17] did not challenge the fundamental ethical and metaphysical assumptions of their Neo-Confucian worldview. Nor were they

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[16] "Pyŏnbang sa Tongbusŭngji so" [A memorial from the Sixth Royal Secretary in Response to Slanderous Accusations], *Yŏyudang chŏnsŏ* I, vol. 9, 43b
[17] Benjamin Elman, *On Their Own Terms: Science in China, 1550-1900* (Cambridge, MA: Harvard University Press, 2005), p. xxxi.

particularly bothered by the different method Westerners used to work out math problsms on paper. However, it was the notion of proofs, the most important component of Western mathematics for Jesuit proselytizing purposes, which had the greatest difficulty in winning acceptance. When they read the Chinese translation of the first books of Euclid's Elements, Chinese, and Koreans, ignored the proofs they contained and treated that book as a collection of "computational rules and theorems."[18]

It is this ability of Confucians to accept Western mathematics without accepting along with it the logic that provided its foundation that cries out for an explanation. The Jesuits who used mathematics as a proselytizing strategy did not expect that sort of response, since, in the assumptions that governed their worldview, such a dismantling of the entire mathematical enterprise into its constituent elements was irrational. To Koreans, however, insisting on proofs in the Western manner was irrational. These differences in understanding of the rational, especially in relation to mathematics, are the focus of this paper.

Koreans first learned about both Western astronomy and the mathematics behind it from an early collection of Jesuit writings entitled Tianxue Chuhan [An introduction to heavenly learning] compiled by the Chinese Catholic convert Leo Li Zhizao (1565-1630) in 1628.[19] Li's title was a deliberate play on the fruitful ambiguity of the term Tian. In Jesuit writings on astronomy and calendrical calculations, "Tian" meant the heavens above where the sun and the stars shined. When Jesuits wrote about their religion, however, "Tian" meant Heaven, the God above whose existence and characteristics were the primary focus of Jesuit proselytizing writings. Leo Li thus presented Western civilization to the Confucian world as the Jesuit missionaries wanted it presented: European science, technology, and mathematics linked inseparably with Roman Catholic philosophy and religion under the rubric of "Tianxue".

Though the Jesuit mission in China was less than five decades old in 1628, Li Zhizao found enough material to fill 52 volumes. The twenty titles of the Tianxue chuhan were divided into two major sections, a section on principle (*li*), containing ten religious works such as Ricci's Tianxue chuhan, and a section on "tools and instruments" (*ki* Ch.*Qi*), containing ten works on mathematics, astronomy, and technology, such as Ricci's translation of the first six books of Euclid's geometry.

The books in the "tools and instruments" section of Tianxue chuhan were written to convince Confucians not only that the Jesuits were superior mathematicians and astronomers but also that they earned that superiority by following a specific mode of accurate reasoning, a logical method which they also followed in their moral reasoning and in their arguments for the existence of God. The missionaries hoped that if Confucians could be convinced to adopt Western techniques for calculating movement in the heavens, they could also be convinced to adopt the Christianity that underlay the

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[18] Ellman, p. 115.

[19] A photocopy edition of *Tianzue chuhan* was published by the Student Bookstore in Taipei, Taiwan in 1965.

civilization that had produced those techniques. Their hope was that Confucians who respected Western knowledge of heaven would also respect Western claims about Heaven.

Such a strategy was partially effective. The Jesuits won an audience. Moreover, they earned Chinese recognition of the superiority of Western mathematics over traditional Chinese mathematics in certain areas. In addition, there were some who took the bait of Western technological expertise and were drawn into belief in Western religion. Li Zhizao and Xu Guangqi (1562-1633) were two such converts in China.[20] However, they were exceptions. Moreover, they appear to have been converted more by the admirable moral character of Matteo Ricci than by those scientific accomplishments of Ricci's that had first brought him to their attention.

In Korea, as already noted, men such as Yi Kahwan and Chŏng Yakchŏn were also initially attracted to "Western Learning" by the mathematical and astronomical skills on display in Jesuit publications. However, Koreans caught in the Jesuits' net of geometrical precision and calendrical accuracy usually lacked the religious fervor and fidelity of Li and Xu. Yi and Chŏng, for example, remained more interested in Western approaches to nature and numbers than in Christian attitudes toward God and morality.[21] Most Koreans who encountered "Tianxue" were able to separate the technology and science they found useful from the theology and Christian worldview which accompanied it. Just as they did with astronomy, Koreans incorporated Western mathematics into a Neo-Confucian framework, eviscerating the Western strategy of using Western superiority in certain technical fields to completely overthrow East Asian confidence in the superiority of the Confucian tradition overall.

Mathematics as a Model of Reasoning

The Jesuit missionaries brought with them to China a European mathematics reborn, the mathematics of the Renaissance. In China they encountered a totally different mathematical tradition, in numerical notation, organization, and theoretical orientation as unlike the Grecian mathematics of the Jesuits as Christianity was unlike Neo-Confucianism. Undaunted by this cross-cultural challenge, Matteo Ricci and other pioneers in the mission to China proceeded to prepare Chinese language introductions to the basics of Western mathematics. Such books as Jihe yuanben [Elementary Geometry], Gouguyi [On the right triangle), and Tongwen suanzhi [The Epitome of Arithmetic], all by Matteo Ricci and all included in the "tools and instruments" section of the Tianzue

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[20] Willard J. Peterson, "Why Did They Become Christians? Yang t'ing-yün, Li Chih-tsao, and Hsu Kuang-ch'i," *East Meets West: The Jesuits in China, 1582-1773,* edited by Charles E. Ronan and Bonnie B. C. Oh, (Chicago:Loyola University Press, 1988), pp. 129-152.

[21] Chŏng Yagyong. Yŏyudang chŏnsŏ [The complete works of Chŏng Yagyong] (Seoul: Sin Chosŏnsa, 1934). I, vol.15, 15a-28b, " Chŏnghŏn myojimyŏng" [An epitaph for Yi Kahwan] ; I, vol. 15, 38b-42b, "Sŏnjungssi myojimyŏng" [An epitaph for Chŏng Yagjŏn].

chuhan, succeeded in winning the attention of Neo-Confucian scholar-officials in China.

Those books also penetrated Korea and were read and discussed by a number of Korean Confucian scholars, including Chŏng Yagyong (better known as Tasan) and his friends. In Tasan's world, before the arrival of those Jesuit publications, mathematics meant Sino-Korean Neo-Confucian mathematics, just as medicine by and large meant Sino-Korean Neo-Confucian medicine and astronomy generally meant Sino-Korean Neo-Confucian astronomy. The pre-modern civilizations of both Confuciandom and Christiandom were unified in a way modern civilizations are not. At least in literate elite circles, ideally all fields of human interest and endeavor were under the domain of one hegemonic Weltanschauung. In Europe that meant everything from art and astronomy to metaphysics and mathematics was supposed to be infused with Christian assumptions and values. Likewise, in China and Korea, the artist, the astronomer, the philosopher and the mathematician were all expected to operate within the confines of Neo-Confucian presuppositions and moral principles.

Ricci and the other early Jesuit missionaries realized they could not launch a frontal assault on such an all-embracing approach to the world so different from their own. Instead they attempted to penetrate the ramparts of Neo-Confucianism by disguising the products of Christian civilization in Confucian clothing, presenting them as augmenting and supplementing Neo-Confucian accomplishments rather than denying those accomplishments outright or posing radical alternatives to them.

Burrowing thus from within, the Jesuits made limited inroads into Confuciandom. However, the camouflage that made those inroads possible ensured also that those inroads would remain limited. For example, they presented European mathematics, particularly Euclidean geometry, as a model of the type of logical reasoning which guaranteed not only accurate results to mathematical problems but also unassailable conclusions to questions which might arise in other areas of human concern, from science to ethics. However, their strategy forced them to present that mathematics within a Confucian mathematical framework, one which assumed a different function for mathematics, a different approach to the framing of problems, a lesser degree of certainty for its conclusions, as well as a narrower range of applicability for its techniques.

The Western mathematics which Jesuit books from China introduced to Koreans contained arithmetic and geometry, nothing more. The coordinate geometry of René Descartes 1596-1650) and the calculus of Issac Newton (1642-1727) and Gottfried Leibniz (1646-1716) were not yet invented at the time the mathematical works in the Tianxue chuhan were composed. The notation system the missionaries had to translate into Chinese was Hindu-Arabic notation, which had only reached the standardized form we used today in fifteenth-century Europe. The symbols so common in stating algebraic problems today did not begin to play a powerful role in the stating and solving of mathematical problems until the end of the seventeenth century, so they were not yet available to the first Jesuits writing in Chinese.[22] Moreover, the mathematical method that

[22] Ifrah, George. *From One to Zero*, translated by Lowell Bair (New York: Viking

was the centerpiece of this prong of the Jesuit proselytizing strategy had only been relatively recently revived in Europe, with the recovery of Euclid from the Arabs. The first usable Latin translation of that geometry classic from ancient Greece was not completed until 1482.[23]

Consequently, the mathematics the Jesuits brought to China and Korea was not modern mathematics. Nor was it markedly superior, in the types of problems it could handle or the accuracy of the solutions it could offer, to Confucian mathematics at its best.[24] However, it was different from the mathematics Koreans were accustomed to. It was abstract, deductive, axiomatic, and precise,[25] and in that lay its appeal as well as its putative proselytizing power.

Jesuit mathematics was abstract both because of the way it conceptualized its fundamental components and because of the way it framed its problems. In the perennial oscillation in the Western world between Platonism and Aristotelianism, Aristotelianism was temporarily ascendant in the universities that trained the Jesuits and provided them with the version of Western civilization they brought to China. That meant that the Jesuits did not view numbers, for example, as Platonic universals, essentially separate from, superior to, and ultimately more real than the material world of individual entities. Contrary to what Platonists sometimes seemed to teach, numbers, in the Aristotelian universe, reflected the multiplicity of the world rather than creating it.

Aristotelian numbers were not totally apart from the world of mundane reality but neither were they totally a part of it. They existed as abstractions from the concrete world of actual objects, stripped of all particular characteristics such as color, shape or mass. With all its sensual particularities removed, a number such as five, for example, could be used to count five dogs, five shades of blue, or even five ways to write the number five without in anyway compromising its meaning and identity. A number derived its reality from the physical realm but it was not subject to the limitations of that realm and consequently was not confined to any particular configuration of physical characteristics.[26] In the philosophical tradition to which the Jesuit adhered, a number was

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Penguin, 1985), pp.428-497; Needham, Joseph. *Science and Civilization in China*. Vol. 3 (London: Cambridge University Press, 1959.), pp. 155; Kline, Morris. *Mathematical Thought From Ancient to Modern Times* (New York: Oxford University Press, 1972), vol. 1, p. 262.

[23] Introduction by Sir. Thomas L. Heath, in Euclid. *The Thirteen Books of the Elements.* (New York: Dover , 1956), p. 97-105.

[24] Regarding the the achievements of Chinese mathematics, particularly in the Song and Yuan, see Needham, op. cit, pp. 1-168, particularly pp. 150-51, and Li Yan and Du Shiran. *Chinese Mathematics: A concise history*, translated by John N. Crossley and Anthony W. C. Lun (Oxford: Clarendon Press, 1987).

[25] Kline, Morris. *Mathematics in Western Culture* (New York: Oxford University Press, 1953), pp. 5-8.

[26] Randall, John H. *The Career of Philosophy* (New York: Columbia University Press, 1962), vol. 1, pp. 303-4.

defined abstractly as nothing more than a "multitude composed of units", with a unit understood merely as "that by virtue of which each of the things that exist is called one."[27]

Similarly, a line was defined as no line that ever existed in visible reality. "A line is that which has length but no breadth," distinguishing it from "a surface, which has length and breadth" (but no depth).[28] Such abstractions from concrete reality were necessary, the Jesuits believed, in order for numbers and other mathematical concepts to have as wide an applicability as possible.

Reliability was as important to the Jesuits as broad applicability was. It was not enough that the Jesuits offered Confucians usable mathematics. That mathematics also had to be trustworthy. For their mathematics to have the persuasive power it needed if it was to play its assigned role in the Jesuit campaign to convert Confucians to Christianity, the missionaries had to convince Confucians that Western mathematics offered a degree of certainty unavailable in Confucian mathematics.

That certainty came from the axiom-driven deductive reasoning found in Euclid's Elements, introduced by Ricci and Xu in Jihe yuanben. In his introduction to that work, Ricci described the steps by which such certainty was obtained. You begin, he said, with explicit definitions of the key concepts to be used in the proposed mathematical arguments. Next you list the axioms that will provide the basis for the proofs of those arguments. Only then do you state the specific problems to be addressed. After that, you go through the steps necessary to solve each problem one by one and, finally, you end up with theorems that are the only possible logical deductions from the application of those axioms to those problems. More complex problems build upon the axioms, definitions and theorems of earlier, simpler problems so that the process can take you step by step from the obvious to the surprising without losing any degree of certitude.[29]

The definitions for such geometrical figures as a line, a plane surface, an acute angle, a circle and an equilateral triangle, and the axioms which accompany those definitions, are abstract enough that the theorems they produce can be applied to all possible physical representations of those mathematical entities, providing the applicability so important as a selling point. Moreover, the axioms, the Jesuits believed, are self-evident and logically undeniable. After all, who could deny that, for example, things equal to the same thing are also equal to one another or that two lines at right angles to one another can only meet in one point on a flat surface?[30] Since those axioms are indisputable, the conclusions

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[27] Euclid, *The Thirteen Books of the Elements*. Translated with introduction and commentary by Sir. Thomas L. Heath (New York: Dover , 1956), vol. 2 (book VII,) p. 277.

[28] Euclid, op. cit, vol 1, book I, p.153. Ricci, Matteo (with Xu Guangqi). *Jihe yuanben* [Elementary Geometry] in Li Zhizao, editor, *Tianxue chuhan* (Taipei: Taiwan Student Bookstore, 1965) vol. IV, pp. 1950-1951.

[29] *Jihe yuanben*, pp.1 935-36.

[30] *Jihe yuanben*, pp. 1970-1977.

drawn from them are equally logically unassailable, providing the reliability the Jesuits needed.

Precision was also important, since reliability would be irrelevant and applicability impossible unless mathematics provided answers both clear and specific enough, for example, to allow astronomers to pinpoint the exact movements of heavenly bodies and military leaders to pinpoint the exact positions of their earthly targets.[31] An unspoken assumption behind this Jesuit argument was that such precision was made possible only by the rigorous definitions, unforgiving logic, and specialized language of Western mathematics.

The epitome of this mathematical certainty, precision, reliability, and applicability was, in Ricci's view, Euclid's Elements. Ricci and Xu's Jihe yuanben translated only the first six books of the thirteen books of Euclid's Elements, covering plane geometry, geometrical algebra, circles, angles, figures inscribed around circles, and ratios. However, for Xu that was sufficient to prove that, with the tools and techniques Western geometry, and only Western geometry, made available, there was no longer any reason to rely on rough estimates in solving problems, no need to doubt the conclusions reached with those tools and techniques, no reason to test those conclusions empirically and no need to change anything.[32] In Xu's view, the geometrical tools Ricci provided were reliable, practical, and specific enough for immediate and unquestioning acceptance by his Confucian audience.

Western arithmetic, though also impressive, did not have quite the unchallengeable authority of Euclid's geometry. Nevertheless, Li Zhizao and Mateo Ricci thought it worth their while to join forces to introduce the Confucian world to Western arithmetical techniques. Their Tongwen suanzhi, a translation of the Epitome of Practical Arithmetic by Ricci's mathematics teacher in Italy, Christopher Clavius (1537-1612), introduced Western methods of adding, subtracting, multiplying, and dividing with pen and paper.[33]

Those methods in themselves were not noticeably superior in either speed or accuracy to calculating with the abacus, which had been in wide use in the Confucian world since at least the fifteenth century.[34] However, a problem worked out on pen and paper could be checked for accuracy in a way a problem solved with an abacus could not. Pen-and-paper calculations left a paper trail that made it possible to go back over the steps leading to the final result, to subtract backwards to verify a product of addition, for example, but the

[31] In his introduction, Ricci wrote at length on the many practical benefits of a knowledge of Euclidean geometry.
[32] *Jihe yuanben*, p. 1942.
[33] Matteo Ricci (with Li Zhizao) *Tongwen suanzhi* [The Epitome of Arithmetic] in Li Zhizao, editor, *Tianxue chuhan* (Taipei: Taiwan Student Bookstore, 1965), vol. V, pp. 2771-3032.
[34] Li and Du, *Chinese Mathematics: A concise history*, pp.184-184; Needham, *Science and Civilization in China*, Vol. 3, pp. 74-80.

beads of the abacus left no traces of their previous positions and movements. [35] This verifiability gave Western arithmetic the extra reliability it needed to win acceptance and to enhance the credibility of Western civilization overall.

Western mathematics was supposed to shatter confidence in Neo-Confucianism, making it the servant of Christianity rather than the other way around. The Jesuit hope was that the study of Western mathematics would teach Confucians how to reason properly. Of course, those missionaries assumed that reasoning properly meant thinking like a late sixteenth-century Roman Catholic. If that did not work, if Euclidean logic proved too difficult for Confucians to imitate, the priests from Europe hoped that at least respect for the products of such logic would extend beyond mathematics to philosophy and theology as well. As Ricci stated of his Jihe yuanben,

"*At the beginning it speaks of veritable principles which are very easy and clear. Gradually accumulating [propositions], in the last sections it brings out subtle, obscure ideas. If one cursorily glances at a couple of the later points, then what is said is difficult to comprehend as well as difficult to believe. If, taking the earlier propositions as proofs, one accumulates evidence and develops [the proof] step by step, then, the ideas being in sequence, frequently on comprehending one laughs [at how easy the later proposition is]*."[36]

Ricci clearly believed that if slow and steady progress could be made from such simple axioms as that if equals are added to equals, the results are equal[37] to such complex propositions as that, in equal circles, angles have the same ratio as the circumferences on which they stand, whether they stand at the centers or at the circumferences,[38] then it would not be that difficult to convince Confucians to go one step further and accept the (at first "difficult to comprehend as well as to believe") proposition that there was but one God in Heaven and that God had sent His only Son to be born as a man among men in a small village in a far-away land over 1,600 years earlier.

The efficacy of Ricci, Xu and Li's mathematical proselytizing depended, of course, on their Confucian audience sharing their assumption that the analytical manipulation of numbers and geometrical figures was the only way to build a practical, precise, and reliable mathematics. Only if Western mathematical formulae was seen to be only as good as the arguments behind them would these Christians be able to convincingly present Euclidean geometry as a model of mathematical reasoning. In other words, if those in China and Korea who read Jihe yuanben and Tongwen suanzhi believed that the usefulness and reliability of tools was a direct reflection of the usefulness and reliability of the techniques used to build them, then acceptance of Euclidean theorems could lead

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[35] See, for example, *Tongwen suanzhi*, pp. 2796-97; Li and Dun, p. 200.

[36] *Jihe yuanben*, p. 1936. I have borrowed the translation of Willard J. Peterson in his "Western Natural Philosophy Published in late Ming China," *Proceedings of the American Philosophical Society*, 117 (1973), p. 311.

[37] *Jihe yuanben*, op. cit., p.1970; Euclid, vol. 1 (book I), p. 155.

[38] *Jihe yuanben*, pp. 2475-76; Euclid, vol 2 (book VI, propostion 33), p. 273.

to acceptance of Euclidean reasoning, preparing Neo-Confucians for arguments for Christianity formulated in the same manner. However, if most Confucians found it relatively easily to adopt the products of Western mathematics while ignoring the process that produced them, then the Jesuit use of mathematics to convert Confucians to Christianity would not be nearly as effective as Ricci, Xu and Li expected it to be. In fact, the latter was the case. Mathematics in the Neo-Confucian world was structured and conceptualized differently from Western mathematics and such differences severely weakened the impact of Jesuit mathematical writings on Neo-Confucian thinking.

The Confucian Mathematical Vision

The Confucians in China and Korea who encountered Jesuit arithmetic and geometry were not mathematical primitives. Their tradition had long provided ways to add, subtract, multiply, and divide. Centuries before Ricci introduced them to Euclid's Elements, they had their own ways of calculating the area of a square, a rectangle, a triangle, a circle, as well as the volume of solids such as spheres. They were comfortable with both fractions and decimals and had worked out an approximation for the ratio of the diameter of a circle to its circumference (π) that was comparable in accuracy to the value used in the West. They had learned to use negative numbers long before Europeans felt comfortable using them. [39]

However, much of the accomplishments of the Song and the Yuan had been forgotten by the seventeenth century, when the first Jesuit translations of Western mathematics appeared. In fact, Chinese mathematics had been in decline for over three centuries at that point. For example, an algebraic technique developed in the thirteenth century for dealing with numerical equations of any degree was forgotten soon afterwards. It was only in the eighteenth century, when Chinese mathematicians had mastered the algebra imported by the Jesuits, that later Confucians were able to understand what their predecessors had achieved.[40]

Nevertheless, despite such setbacks, even in the late Ming the Chinese still maintained superiority over the West in some areas. To ensure that the Tongwen suanzhi he and Ricci had written would have maximum utility and gain wide readership, Li Zhizao had to supplement its European arithmetic with several Chinese algebraic calculating techniques Europeans had not yet discovered.[41] Li, Xu and Ricci hoped that those contributions by Chinese mathematics, incorporated into a Western mathematical framework, would further bolster their argument that Confucianism and Catholicism were compatible, with the understanding, of course, that Confucianism was to play the supporting rather than the dominating role.

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[39] Needham, Joseph. *Science and Civilization in China*. Vol. 3 (London: Cambridge University Press, 1959), pp. 81-102.
[40] Ho Peng Yoke. *Li, Qi, and Shu: An Introduction to Science and Civilization in China* (Hong Kong: Hong Kong University Press, 1985, p. 92; Li and Du, pp.135-140; Needham, op. cit, pp. 129-133.
[41] Li and Du, p. 201.

In the philosophy the Jesuits brought with them to China, abstract concepts underlie the comprehension and manipulation of concrete particulars. For example, individual numbers such as 2, 55, or 3233 can be understood and utilized only in as much as they share in the collective qualities of numbers in general. In other words, 2 must be treated in any mathematical operation as any other number with its characteristics would be treated. There may of course be a group of overlapping general categories governing how a particular number will behave and perform (it may be a whole number, a positive number, a rational number, a prime number, etc.), but nonetheless that number will be subject to those rules that govern all numbers whose properties it shares.

Confucian mathematicians understood, of course, that numbers shared many common properties. Otherwise, mathematics would not be possible. However, they neither emphasized nor explicitly stated what those common properties were nor what universal rules governed them. Their mathematics tended to be a very practical mathematics, seeking concrete solutions to specific problems rather than general rules governing a class of problems. A method that produced a correct solution to a problem would be applied to a number of other similar problems, rather than abstracted into the form of a rule framed in symbolic universal terms. If that method turned out to have wide applicability, then that applicability would be shown, not by restating it in the form of a theoretical principle, but by providing several examples of that method in operation. This is inductive reasoning, unlike the deductive reasoning that shaped Euclid's Elements.

A good example would be the Confucian version of the Pythagorean theorem, found in one of the oldest Chinese mathematical classics, the Zhoubi suanjing. In Euclidean geometry, that theorem states that in any right triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides. The Zhoubi suanjing version is, of course, more specific, stating that in a triangle 3 units wide and 4 units high the diagonal joining the two corners will be 5 units long. In the Euclidean geometry the Jesuits brought to China, a general theorem could not be limited to a geometric figure of any one specific size. It did not make any difference how long each of the three sides was for the Pythagorean theorem to be applicable. All that was necessary was that they were the three sides of a right-angled triangle. For Confucians, however, those three sides had to be given specific numerical values. By analogy, the same theorem could then be applied to other right-angled triangles with sides of different specific numerical values.[42]

The contrast between Euclidean abstractness and Confucian concreteness shows up even in the way basic geometric figures are defined. The Confucians chose to define a rectangle, for example, by saying that it originated from the multiplication table that makes 9 times 9 equal 81.[43] Euclid's Elements, on the other hand, defined it as a figure "contained by the two straight lines containing the right angle."[44] Confucians preferred to visualize a particular rectangle when talking of rectangles in general but Europeans

[42] Needham, p. 22.
[43] Ibid.
[44] Euclid.1. p. 370 (Book II, definition 1); *Jihe yuanben* p. 1963.

preferred to talk of rectangles in general before addressing the properties of a particular rectangle. Such differences are deeper than mere differences of language. They reflect different ways of approaching reality.

It is of course possible to write as abstractly in the terse Chinese of these mathematical classics as it is to write concretely in European languages. Centuries earlier, Mohists had argued for what appear to be almost Euclidean concepts.[45] Moreover, Ricci, with help from Xu and Li, was able to translate Euclid into understandable literary Chinese. However, his awkward renditions of Western abstractions into Chinese lacked the rhetorical power necessary to persuade Confucian readers to adopt the same approach.

In his translation of the proof of the Pythagorean theorem, for example, rather than base his argument on a specific right triangle with sides 3, 4, and 5 units long, Ricci instead talked about right triangles in general, with sides abstractly labeled kap-ŭl (AB), ŭl-pyŏng (BC) and pyŏng-kap (CA), from its angles kap, ŭl and pyŏng. The resulting sentences, such as "Let there be a triangle kap-ŭl-pyŏng, with a right angle of ŭl-kap-pyŏng" were neither aesthetically pleasing nor visually compelling to their intended audience.[46]

Confucians preferred working with abstractions expressed in concrete terms and with specific numbers rather than with nebulous substitutes. Whether in mathematical or in other modes of discourse, they tended to favor abstractions created by assigning a wider range to already existing words drawn from everyday life over abstractions created by neologisms lacking a history of tangible reference. Moreover, Confucian mathematicians were more inclined to algebraic than geometric formulations, since they were more interested in the relations between particular numbers than in the properties of generic lines, planes, and solids.[47]

Consequently, an argument couched in geometric generalities was unlikely to be imitated by Confucian scholars. Those Koreans and Chinese who accepted the conclusions presented in Western mathematical works, and borrowed the techniques they offered, by and large ignored the process by which Westerners had reached those conclusions and produced those techniques. The Jesuit missionaries in China intended mathematics to serve as a proselytizing tool, convincing Confucians that the Western mode of reasoning was superior and deserving of adoption. The Confucian pragmatic bent, the preference for specific and immediate applicability, undercut the theoretical force of the Jesuit argument, severing the intended link between the accuracy of the results the Jesuits' mathematical formulae produced from the validity of the deductive reasoning by which those formulae had been discovered.

A cursory comparison of a Chinese mathematical classic with a Jesuit translation of Western geometry or arithmetic is enough to confirm the differences between Euclidean and Chinese approaches to mathematics. A Han dynasty work which in effect defined

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[45] Needham, pp.91-94.
[46] *Jihe yuanben* p. 2059-2066.
[47] Needham, pp. 23-24.

mathematics in Confuciandom, the Jiujang suanshu [Nine chapters on the mathematical art], had as its chapter headings such titles as "measuring fields," "cereals," and "making taxes fair."[48] Ricci's Jihe yuanben, on the other hand, has no specific chapter titles but if it did they would be named for mathematical operations rather than for the ways in which those operations could be used. Jihe yuanben is organized along theoretical lines, starting with the basics of plane geometry in chapter one and going on to circles, figures inscribed around circles, and ratios in later chapters. The Tongwen suanzhi is similar. It does have chapter headings, and those headings, such as "the laws of addition" and "the rules for turning remainders into fractions," show again that the prime focus in Jesuit publications is mathematics as a discipline rather than mathematics as a tool.

The chapters in Western and Confucian mathematical texts are also structured differently. In Jihe yuanben, for example, each chapter opens with definitions of the key terms and operations in the problems that chapter will attack. Each problem, in turn, opens with the general proposition that it is intended to prove. Next the geometric figure that exemplifies that proposition is described, with all its kap-ŭl lines and pyŏng angles. Finally, the proposition is proved, step by step, using kap, ŭl, pyŏng, etc. for the numerical values being manipulated instead of real numbers. This contrasts with such Confucian works as the Jiujang suanshu, which begins each section by solving three to five specific examples of the same general type of problem and then suggests a common element in all those solutions. In other words, Euclidean geometry begins with general statements and deduces from them methods for solving particular problems but Confucian mathematics begins with particular problems and induces from them methods for solving such problems in general.[49]

Preferring induction to deduction, Confucian mathematicians never developed the concept of rigorous proof so central both to Euclidean geometry and to the Jesuit use of that geometry for proselytizing purposes.[50] Scholastic Christian theology encouraged the Jesuits' deductive approach. In a universe believed created by a God who was both logical and consistent, it made sense to look first for the rational rules with which God had designed all of his creations, including the rules behind numbers and other mathematical entities. Just as God had done, man too should go from principles to particulars, or so the Jesuits assumed.

Neo-Confucians, on the other hand, adopted a different stance toward the cosmos, a stance that prompted their predilection for induction. Their universe was not created by a deity who used abstract rational principles as building blocks. Such a universe was too static for the Neo-Confucian worldview. As they conceived it, the cosmos was a dynamic network of appropriate interrelationships. Such a cosmos was best understood within, by probing that network (K. *kungni*) in order to observe it in operation. Once a particular

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48 Li and Du, pp.33-37; Ho, pp. 64-65; Kim Yongun and Kim Yongguk. *Han'guk suhaksa* [The history of mathematics in Korea] (Seoul: Yŏlhwadang, 1982), pp. 53-60.
49 Li and Du, p. 194.
50 Lebbrecht, U. J. *Chinese Mathematics in the Thirteen Century:The Shu-shu chiu-chang of Ch'in Chiu-shao*, p. 10.

pattern of interaction within the overall network had been identified, Confucians would then extend that specific mode of relational functioning to other, similar interrelationships. This "pushing of the pattern" (K. *ch'uli*) to encompass a larger range of phenomena allowed Confucian mathematicians to construct general rules from a few concrete examples.[51] Thus in the Confucian mathematical world induction was supposed to precede deduction, grounding generalizations in specific mathematical phenomena, the opposite of the Western reliance on universals and logical abstractions to analyze and manipulate mathematical particulars.

Korean Neo-Confucians shared that pragmatic, inductive, algebraic Confucian mathematical universe with the Chinese and were no more willing or able than the Chinese were to bridge the conceptual gap between European and East Asian models of mathematical reasoning. Just as their fellow Neo-Confucians in China did, Korean scholars were able to appreciate the rigor and accuracy the Jesuits brought to mathematical calculations without, however, unduly appreciating, admiring, or adopting the Western way of conceptualizing mathematical problems.

One example of a Korean scholar who admired the mathematical accomplishments of the Jesuits but declined to adopt their mode of reasoning is Sŏngho Yi Ik (1681-1763). Sŏngho had read Jihe yuanben, along with a number of Jesuit publications, and by and large was impressed by the scholarship it contained.[52] He cited with approval Xu Guangqi's prefatory statement that the study of mathematics in general, and geometry in particular, would help those who study *li* to settle down and strengthen their powers of concentration: "Those who follow this established method will develop the ability to reason skillfully so that they will become careful and precise in their thinking."[53] Sŏngho recalled when young boys first began studying, their attention wanders. However, once they are introduced to mathematics, they become more focused and are then able to penetrate deeply into the meaning of the Classics. Such are the benefits to be gained from studying mathematics and therefore, Sŏngho argues, "mathematics should not be dismissed as beneath the dignity of a gentleman."[54]

Despite the high regard in which he seemed to hold the mathematics in Ricci's translation of Euclid's Elements, Sŏngho did not imitate suggested methods for attacking mathematical problems. When he discussed such mathematical topics as the relationship between the diameter of a circle and that circle's circumference or the relationship between the base and the altitude of a right triangle to that triangle's hypotenuse, Sŏngho reasoned as Confucian scholars had reasoned for centuries when dealing with numbers and geometric figures. He examined collections of similar problems with similar solutions rather than trying to deduce general computational formulae from abstract

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[51] Needham, pp. 163-65.
[52] Han Ugŭn. *Sŏngho Yi Ik yŏn'gu* [A Study of Yi Ik] (Seoul: Seoul National University Press, 1980), p. 49.
[53] Yi Ik, *Sŏngho sasŏl yusŏn* [Selections from the Sŏngho sasŏl], edited by An Chŏngbok (Seoul: Myŏngmendang, 1982), "sanhak" [mathematics] p. 443. Yi is citing p. 1941.
[54] Yi Ik, ibid.

premises. For example, he points out that a right triangle with a base three units long and an altitude four units high would have a hypotenuse exactly five units long. However, a right triangle with a base five units long and an altitude five units high would have an hypotenuse seven and a fraction units long. His conclusion is that only the specific right triangle which has a base and an altitude 3 and 4 units long respectively could have a hypotenuse whose length can be given in whole numbers.[55] Even when discussing the Pythagorean theorem, Sŏngho remained a traditional Neo-Confucian more comfortable with induction from concrete examples than deduction from transcendental forms.

Sŏngho was not the only Korean in the eighteenth century to overlook or minimize the differences between European and Sino-Korean mathematics. Even Confucian scholars and professional mathematicians who studied mathematical texts, including Jesuit-authored works, at great length and wrote volumes, rather than pages, on what they had learned from those books tended to absorb the Jesuit contributions into the larger framework of Confucian mathematics. Koreans exploited Jesuit mathematics, treating it as a mine from which they could extract interesting examples of mathematical operations as well as useful calculating techniques. However, they used those operations and techniques within a thoroughly Confucian context. They ignored the philosophy behind them, particularly the confidence placed in abstract axioms and theoretical proofs.

Many of those who wrote mathematical treaties in seventeenth- and eighteenth-century Korea showed some familiarity with Jesuit publications. Ch'oi Sŏkchŏng, for example, included Tianzue chuhan among the many works he had utilized in preparing his survey of mathematical thought and achievements. Yet he remained an orthodox Korean Neo-Confucian, faithful to the spirit and approach of the Jiujang suanshu of China's Han dynasty.[56] The same is true of Hwang Yunsŏk (1729-1791), another *yangban* writer on mathematics.

Hwang's two books on fundamental mathematics show that he was aware of Western accomplishments, particularly those found in Ricci's Tongwen suanzhi and in the Ch'ing mathematical encyclopedica, the Shuli jingyun, but was little influenced by them.[57] For example, Hwang borrowed a lengthy list of the practical applications of the Pythagorean theorem from Tongwen suanzhi. However, the Pythagorean theorem per se was only described, not proven, unlike its treatment in Jihe yuanben. Instead of diagrams of triangles with angles labeled *kap*, ŭ*l*, and *pyŏng*, showing that the essential properties of right triangles insured that the suggested procedures would be valid for all possible right triangles, this selection ended instead by reassuring the readers that if they extended these techniques to a variety of situations with right triangles of differing sizes, they would grow accustomed to them and become comfortable trusting in their results.[58]

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55 Yi Ik, "Kyŏng il pang o" [On right triangles, fractions, and π], p. 444.

56 Kim Yongun and Kim Yongguk, op. cit. pp. 233-240.

57 Ibid, pp. 253-256; Kim Yongun, editor. *Han'guk kwahak kisulsa charyo taegye: suhak p'yŏn* [A collection of materials for the history of science and technology in Korea: Mathematics], (Seoul: Yŏkang, 1985), vol 3, pp. 1-360.

58 *Han'guk kwahak kisulsa charyo taegye: suhak p'yŏn*, vol. 3, Hwang Yunsŏk, *Sanhak*

Hwang, in this Sanhak immun [Introduction to mathematics], next provided several concrete verbal illustrations of how the Pythagorean theorem could be used to find the length of the base once the hypotenuse and the altitude of a right triangle were known or how it could be employed to calculate the size of a circle inscribed inside a right triangle. He called this section Kugo ŭi [C. Gouguyi, On the right triangle], but unlike the Jesuit work by the same name, Hwang's abbreviated discussion left out all the diagrams Ricci and Xu had used to turn their illustrations of specific mathematical problems into assertions of universal mathematical laws.[59]

Nor did Hwang pause to demonstrate how those particular applications of the Pythagorean theorem were discovered or justified theoretically. He merely reminded his readers that these operations were nothing more than extensions of techniques developed for calculations with a specific right triangle with sides 3, 4, and 5 units long respectively.[60] Practice was his proof. Like others before him, Hwang accepted the results but ignored the logic of Jesuit mathematics.

Hwang's better known contemporary, Hong Taeyong (1737-1783), did the same. Hong is applauded today as almost modern in his interest in mathematics, science, and technology.[61] He is unusual among Koreans interested in mathematics for having not only read Jesuit publications but also having met and talked with Jesuit missionaries in Beijing.[62] However, there is little in Hong's three-volume Chuhae suyong [Essential calculating techniques] that reflects a new paradigmatic approach to mathematics. His mathematics remains Confucian mathematics, focusing on how calculating techniques are applied rather than on how they are derived and justified.

Hong does not actually show how his calculations would look on paper, though that is what Ricci and Hsü had done in Tongwen suanzhi. In other words, he says "place the number you are going to multiply directly above the number you are going to multiply it by" without actually writing it that way himself. Nor does he utilize the main advantage pen-and-paper calculations offer over calculations with an abacus: ease in rechecking calculations.[63] Despite this slight change in medium, Hong shows no other noteworthy

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immun, pp. 180-182; *Tongwen suanzhi*, p. 3270-3272.

[59] Matteo Ricci (with Xu Guangqi). Gouguyi [On the Right Triangle] in Li Zhizao, editor, *Tianxue chuhan* (Taipei: Taiwan Student Bookstore, 1965), vol. VI, pp. 3547-3587.

[60] Hwang Yunsŏk, ibid., pp. 180-189, esp. p. 186.

[61] See, for example, Kim T'aejun. *Hong Taeyong kwa kŭ ŭi shidae* [Hong Taeyong and his times] (Seoul: Iljisa, 1982). Kim summarized his interpretation of Hong in English in "The Thought and Literary Achievement of Hong Tae-yong," *Korea Journal*, vol. 28, no. 5 (May, 1988), pp. 37-54.

[62] Gari Ledyard, "Hong Taeyong and His Peking Memoir," *Korean Studies*, vol. 6 pp. 63-104; Hong Taeyong, *Tamhŏnsŏ*, woejip, " Yup'omundap", vol. 7, 9a-15a.

[63] Kim Yongun and Kim Yongguk, op. cit. pp. 256-260. Hong Taeyong, *Tamhŏnsŏ, woejip*, IV-VI. "Chuhae suyo." Note that Hong usually calculates from left to right, in the traditional Sino-Korean manner, though Ricci calculated from right to left when he

innovations in his methods. His mathematics remains Confucian mathematics, focusing on how calculating techniques are applied rather than on how they are derived and justified.

His discussion of calculations involving right triangles for example, shows no traces of Euclidean logic. Hong borrows Western terminology, just as Hwang and many others had done. But he draws no diagrams and provides no proofs. As for as he is concerned, Western techniques may look different from those found in the Jiujang suanshu, but their general principles, particularly their shared reliance on ratios, are the same.[64] One reason Hong may have overlooked the fundamental differences between Western and Confucian geometry is that he did not have a copy of Jihe yuanban at hand to refer to. What he knew of Western geometry he learned from the Chinese version of it in a Ch'ing text, Shuli jingyun, which left out all the proofs Euclid and Ricci had provided.[65]

Though, unlike Hong, he had access to Ricci's version of Euclid's Elements, one of the disciplies of Tasan Chŏng Yagyong (we don't know which disciple) apparently agreed that Western mathematicians did not depart significantly from the way mathematics traditionally had been conceived and practiced in China and Korea. Though Tasan was much more flexible and open to new ideas than the vast majority of his contemporaries, his student, and probably Tasan as well (since he left no written indicators of a positive impression of Western mathematics) failed to recognize the novelty or grasp the significance of the Western-style mathematics.

We can get a hint of Tasan's attitude toward Western mathematics in his disciples's 530-page manuscript entitled Kugo wŏllyu [A comprehensive account of calculations with right triangles], which is included in the Yŏyudang chŏnsŏ poyu [An addendum to the Complete Writings of Yŏyudang Chŏng Yagyong]. It appears unlikely that this work is actually by Tasan, though the fact that is included in a collection of works either by or ascribed to him suggests it was written either by a relative or a disciple.[66] Probably based heavily on an unidentified Chinese source, this collection of examples of mathematical problems reveals nothing more than the usual tendency to Tasan and his disciples to examine in exhausting detail whatever subject is being addressed. It includes no deductive axioms, no diagrams, and no proofs, only example after example of the types of calculations that are available to those who understand the ratios governing the relationships within a right triangle.[67] Whoever wrote this text responded to Jesuit mathematics the same way other Korean had responded. He read Jesuit books to learn

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introduced pen-and-paper calculation. See Li and Du, p. 201.

[64] Hong, ibid. V: 13a-18a.

[65] Hong, IV. 5. Mikami, Yoshio. *The Development of Mathematics in Chain and Japan*. (New York: Chelsea Publishing Co., 1974) reprint of 1913 edition), p. 117.

[66] Kim Ŏnchong, "Yŏyudang chŏnsŏ poyu ŭi chŏjakpyŏl chinwi munje-e taehayŏ (ha)" [a look at the various items in the Addendum to the Yŏyudang chŏnsŏ in regard to whether they are genuine or not, part III], *Tasanhak*, 11 (Dec. 2007), pp. 323-28.

[67] Chŏng Yagyong, *Yŏyudang chŏnsŏ poyu* [An addendum to the Yŏyudang chŏnsŏ] (Seoul: Kyŏngin munhwasa, 1974), vol. 4, p. 1-530.

how to perform certain calculations, frustrating the Jesuit missionary plan to have readers ask not only how but also why.

A why question was supposed to lead to a two-part answer. The Jesuits assumed that Confucians impressed with the mathematical wizardry of Catholic priests from the West would wonder why these strange men from a far away land were able to surpass the achievements of the sages of China. The explanation they were to come up with was that European civilization was at least the equal of Confucian civilization, with traditions and practices as trustworthy and as respectable as the traditions and practices of Confucian civilization and, moreover, that Catholics priests understood the world of numbers and geometric shapes so well because they had superior insight into the rational design of the cosmos through their superior knowledge of the mind and will of the Divine Designer.

Ironically, the effectiveness of Jesuit mathematics as a proselytizing tool seemed to be in inverse proportion to the amount of attention an intended target dedicated to understanding and utilizing it. It was most effective on those either little interested in mathematics or incapable of mastering the new calculating tools the Jesuit offered. None of the Koreans who wrote about Western mathematics, with the exception of Tasan, were favorably impressed with Christian theology. Hwang Yunsŏk, for example, stated quite clearly that Western superiority in mathematics and calendrical science did not mean that what they had to say about more important subjects, such as human nature and *li*, was equally credible.[68] And even Tasan, though he may have become a somewhat of a monotheist, remained for most of his life more Confucian than Catholic.[69]

Western mathematics could not many lead Neo-Confucians to God because it could not even lead many Koreans to accept the Western way of conceiving and manipulating mathematical entities as the one and only way to do mathematics. The reasons the Western approach to mathematics, despite its strengths in certain areas, failed to replace the traditional Sino-Korean approach in the minds of Korean Confucians such as Tasan, Yi Ik, Hwang Yunsŏk, and Hong Taeyong are basically the same reasons Western astronomy and cosmology was forced to accept a subordinate role. Historically, it was not yet time for Western mathematics to claim overwhelming superiority over Confucian mathematics. The Rennaissance mathematics the Jesuits brought to China was not as powerful as the mathematics of modern times. The range and types of problems Sino-Korean mathematics could not solve was not that much greater than the range and types

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[68] Ha Sŏngnae. "Ijae Hwang Yunsŏk ŭi sŏyang kwahak sasang suyong" [Hwang Yunsŏk's acceptance of Western scientific thought], *Chŏnt'ong munhwa yŏn'gu*, 1 (Dec., 1983), pp. 51-52.

[69] Kim, Yong Sik, "Science and the Confucian Tradition in the Work of Chŏng Yagyong," *Tasanhak* 5 (June, 2004), pp. 127-168; Don Baker, "Koreanizing Confucianism: Tasan Chŏng Yagyong and His Commentaries on *Mencius and the Doctrine of the Mean,* " in *East Asian Confucianism: Interaction and Innovations*, (New Brunswick, New Jersey: Confucius Institute at Rutgers University, 2010). pp. 106-20

of problems the Jesuits could not solve with their mathematics, so there was little practical imperative to abandon one for the other.

Sociologically, though mathematics was held in high esteem, mathematicians in Korea were not. Though they ranked above peasant commoners, they nonetheless were below the *yangban*. In fact, they were the quintessential *chungin,* a social class composed of technical specialists. Professional mathematicians formed a closely-knit group in Seoul who intermarried among themselves and passed on to their descendants the knowledge of mathematics necessary to pass the lower-level civil service examinations.[70] It was in their vested interest to preserve the supremacy of the Sino-Korean mathematical tradition which they had mastered and which gave them their livelihood and it was in the best interest of *yangban* to avoid identification with those lower status professional mathematicians. Both factors worked against anyone, *yangban* or *chungin*, arguing for the abandonment of Sino-Korean mathematics and the wholesale adoption of the imported Western approach.

But the most important reason for the failure of the Jesuit use of mathematics to proselytize was that, conceptually, the analytical and abstract character of Western mathematics conflicted with the Neo-Confucian preference for a integrative and concrete approach. Renaissance mathematics, with its insistence on breaking the universe up into discrete points and lines, threatened to tear apart the cosmic unity so important to orthodox Neo-Confucian thinker. Moreover, the Western focus on geometric shapes ran counter to the Confucian concentration on algebraic relationships. This is the distinction between form and function that divided not only Western from Sino-Korean mathematics but also Scholastic philosophy and values from Neo-Confucian philosophy and values. As a result, the mathematics the Jesuit missionaries presented to the Confucian world lacked enough persuasive power to overthrow a methodological stance toward the world of numbers which had reigned in China and Korea for centuries.

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[70] Kim Yong Woon (Kim Yongun), "Pan-paradigm and Korean Mathematics in the Choson Dynasty," KOREA JOURNAL, 26, no. 3 (March, 1986), pp. 25-46; Han'guk suhaksa, pp.192-199.