Dutch Algebra and Arithmetic in Japan before the Meiji Restoration

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Abstract

This paper gives an overview of the scarce occasions in which Japan came into contact with Western arithmetic and algebra before the Meiji restoration of 1868. After the refutation of persistent claims on the influence through Japanese students at Leiden during the seventeenth century, it concentrates on the reception of Dutch works during the last decades of the Tokugawa *shogunate* and the motivations to study and translate these books. While some studies based on Japanese sources have already been published on this period,[2] this paper draws from Dutch sources and in particular on witness accounts from Dutch officers at the Nagasaki naval school, responsible for the instruction of mathematics to selected samurai and *rangakusha*. Two Japanese textbooks on arithmetic from that period are viewed within the context of this naval training school.

Introduction

At the beginning of the twentieth century, historian Tsuruichi Hayashi (1873 – 1935) published a well-received series of articles in the Dutch mathematical journal *Nieuw Archief voor Wiskunde*. His "Brief History of the Japanese Mathematics" (sic) is the first published account of the *wasan* tradition in a Western language.[3] This comprehensive chronological overview of over 120 pages provides many details on Japanese authors of *wasan* books, the schools in which they practiced mathematics and the mathematical methods they developed. For the interest of this paper, we discuss the few references to Dutch books cited by Hayashi. He reports on recorded evidence that the first (unidentified) Dutch book on mathematics in Japan was imported by the medical doctor, Ryōtaku Mayeno in 1772.[4] His overview includes four Japanese works on mathematics which contain explicit references to Dutch books, though the precise Dutch sources are unknown:[5]

- Ryuho Nakano, *Rekishō shinsho*, (暦象新書) 1797, on calendar-making [based on a book by John Keill, translated into Dutch by Johannes Lulofs]
- Kaikō Yamaji, *Seireki Shinhen*, 1837, on European calendars [by Beima, wich possibly is Abraham van Bemmelen]

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[2] Notably two publications by Prof. Sasaki: Sasaki, C. "The history of Japanese mathematics with the Adoption of Western Mathematics in Meiji Japan, 1853-1905", in C. Sasaki, M. Sigiura, J. W. Dauben (eds.) *The Intersection of history and mathematics*, Basel: Birkhauser, 1994, pp. 165-186, and Sasaki, C. "The Emergence of the Japanese Mathematical Community in the Modern Western Style, 1855-1945" in K. H. Parshall, A. C. Rice (eds.), *Mathematics Unbound: The Evolution of an International Mathematical Community, 1800-1945*, Providence, RI.: American Mathematical Society, 2002, p. 229-252.

[3] Hayashi, T. "A brief history of the Japanese mathematics (part 1)", *Nieuw Archief voor Wiskunde*, Serie **2**, 6, 1905, p. 296-361, and Hayashi, T. "A brief history of the Japanese mathematics (part 2)", *Nieuw Archief voor Wiskunde*, Serie **2**, 7, 1905, p. 105-163. The term '*wasan*' designates Japanese mathematics from the Edo period (1603 – 1868).

[4] Hayashi, T. "A brief history", part 2, p. 158.

[5] In these and the following references to books, we expanded the title, author and publisher information as found in current catalogues. For Japanese books we added the Kanji.

- Okumura and Mori, *Katsuyen-hyo*, 1857 [including trigonometrical tables]
- Hanai, *Seizan sokuchi*, **(西算速知)** 1856

Hayashi concludes his history with a sad note on the fate of *wasan* books. During the turmoil of the Meiji restoration, the large collection of Kyō Uchida was moved into safety from Tokyo to the Shimosa province. The books were considered too vulnerable in the hands of the new regime which had radically departed with the old mathematics. Later, an accidental fire destroyed the whole collection, which makes Hayashi conclude that “now almost all the valuable books written on *wasan* were lost by these events and could not be found in our country. So the mathematics peculiar to our country had entirely decayed and could not become flourishing again”.[6] However, Hayashi withholds the fact that he himself was an ardent book collector.[7] He left an enormous collection of 14,470 *wasan* books and manuscripts, now the bulk part of the *wasan* collection at Tohoku University. Together with two other minor collections, Tohoku university library now holds the largest collection of *wasan* books in the world consisting of 18,335 items. It is estimated that this accounts for two-thirds of the books produced on this subject.

Hayashi’s *History* was followed by some notes on Dutch books found in Japanese libraries.[8] The first one was on astronomy. The second one included a list of 64 Dutch mathematical titles of which some written in kanji and katakana. We distilled the books on arithmetic and algebra. The Dutch term for algebra is ‘stelkunst’. Like many Dutch mathematical terms it was coined by Simon Stevin during the sixteenth century. It literally means ‘the art of posing’, a very accurate depiction of the analytical nature of algebra. Arithmetic was called ‘cijferkunst’, the art of numbers. Both terms have passed into oblivion during the twentieth century. We found nine items:

- de Gelder, Jacob (1793) *Grondbeginselen der cijferkunst*, Rotterdam: N. Cornel.
- de Gelder, Jacob (1847) *Allereerste gronden der cijferkunst*, s’Gravenhage and Amsterdam: Gebr. van Cleef.
- de Gelder, Jacob (1836) *Beginselen der stelkunst, ontworpen naar haren tegenwoordigen staat van vordering en beschaving*, Amsterdam: Gebr. van Cleef.

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[6] Hayashi, T. “A brief history”, part 2, p. 161.

[7] The parallel with Western book collectors and historians of mathematics is obvious. Guillaume Libri, who published the classic *History of mathematics in Italy* (Libri G. *Histoire des Sciences Mathématiques en Italie, depuis la Renaissance des Lettres*. Paris, 1838-41, 4 vols.) owned thousands of books and manuscripts, most of which were sold during his lifetime. At some point he was accused of having stolen them from libraries. The many appendices in this three-volume work contain transcriptions from books and manuscripts of his own library, including the *Trattato d’abaco* by Pierro della Francesca. The second example is David Eugene Smith who wrote the two volume work *History of mathematics*. According to an inventory made in 1940 he owned over 20,000 items on mathematics, including 11,000 rare books, numerous manuscripts, autographs and portraits, now part of the Columbia university library collection. See Simons, Lao Genevra, “David Eugene Smith—In memoriam”, *Bulletin of the American Matematical Society*, 51, (1), 1945, p. 40-50. After his death in 2005, David Pingree also left a collection of 22,000 books and manuscripts on Ancient mathematics and exact sciences, mostly from India, to Brown University Library.

[8] Hayashi, T. “A list of Dutch books on mathematical sciences imported from Holland to Japan before the restoration in 1868”, *Nieuw Archief voor Wiskunde*, serie **2,** 7, 1905, p. 232-238. Hayashi, T. “On the Japanese who was in Europe about the middle of the seventeenth century” (in Japanese), *Journal of the Tokyo Physics school*,1905. Hayashi, T. “Some Dutch books on mathematical and physical sciences imported from Holland to Japan before the restoration in 1868”, *Nieuw Archief voor Wiskunde* serie **2**, 9, 1909, p. 39-41. Hayashi, T. “How have the Japanese used the Dutch books imported from Holland?”, *Nieuw Archief voor Wiskunde*, serie **2**, 9, 1909, p. 42-48

- Ghijben, Jacob Badon and H. Strootman (1850) *Beginselen der hoogere stelkunst voor de kadetten der artillerie en genie*, Breda: Broese & co.
- Lacroix, S.F. (1825) *Beginselen der stelkunst : ten gebruike van de Kadetten der Koninklijke Artillerie- en Genieschool te Delft*, s'Gravenhage en Amsterdam: Gebr. van Cleef, (translated from French by I.R. Schmidt).
- Lobatto, Rehuel (1845) *Lessen over de hoogere algebra*, s'Gravenhage en Amsterdam: Gebr. van Cleef.
- Strootman, H. (1862, 1864) *Beginselen der cijferkunst*, Breda: Hermans en zoon.
- Wiskundig Genootschap (1820, 1846) *Verzameling van nieuwe wiskundige voorstellen*, Amsterdam: Weijtingh en Van der Haart.

Most of these Dutch books were produced for the purpose of teaching army officers and engineers in Holland, a tradition which originated from the polytechnics at the end of the eighteenth century with the French author Lacroix as the best known representative.

The third note is quite interesting.[9] It describes a catalogue of close to one thousand Dutch books owned by the Tokugawa shoguns. The catalogue and some of the books were found at the Shizuoka normal school, not far from Tokyo. It includes an impressive collection of 246 Dutch dictionaries. The list of mathematical works from this collection compiled by Hayashi does not contain any surprises. It lists two other editions of the algebra by Ghijben (1843, 1854), and another copy by Lacroix (1825).[10]

Especially of interest is his letter to the editorial board of *Nieuw Archief voor Wiskunde* which one the editors turned into the fourth note.[11] Here we find several witness accounts of "aged Japanese scholars who have learned European sciences through the Dutch language". Knowing that in 1872 it was decided that only *yōzan* (European mathematics) was to be taught at Japanese schools, Hayashi's publication is only 32 years after the end of the *wasan* period, with several practitioners of this tradition still alive. These aged scholars had difficulties recalling the precise circumstances of their *wasan* experiences "because the whole state of things has been so rapidly or rather violently changed". He then proceeds to describe the *sakoku* policy, how the Tokugawa's from 1603 prevented the propagation of Christian religion and ordered a ban on Western books, including books on science. Anyone caught with possession of these books was severely punished. However, at the beginning of the eighteenth century under Yoshimune Tokugawa, who reigned from 1716 to 1744, the prohibition was somewhat relaxed. The shogun himself showed an interest in Western astronomy and calendar composition and started building a library, of which later the catalogue as been found, as discussed above. In the middle of the nineteenth century Kyō Uchida taught mathematics to several hundreds of students in Tokyo, adopting the Dutch word *Mathematische* for the name of his school.[12] Any Dutch book that could be found on one of the ships became a precious item and circulated within a small group of Japanese

[9] Hayashi, T. "Some Dutch books".
[10] Jansen, Marius B. "New Materials for the Intellectual Study of Nineteenth-Century Japan", *Harvard Journal of Asiatic Studies*, **20** (3-4), 1958, p. 567-597, describes the larger combined catalogue including the books of the *Bansho shirabe-sho* and mentions that the section *Sanjutsu* (Arithmetic) contained 14 items. He list one title not mentioned by Hayashi: Schmidt, I.R., *Beginselen der differentiaal- en integraal-rekening ten gebruike van de Kadetten der Koninklijke Artillerie- en Genieschool te Delft.* Amsterdam: Gebroeders van Cleef, 1822.
[11] Hayashi, T. "How have the Japanese used the Dutch books?"
[12] In Hayashi, T. "Some Dutch books", p. 147 it is spelled *Mathematica.* Sasaki, C. "The Emergence of the Japanese Mathematical Community" p. 230, also uses this Latin spelling.

scholars called *rangakusha*.[13] Hayashi was told about a book dealer in Edo (now Tokyo) who specialized in Dutch books. In 1856 the *Bansho shirabe-sho* (Institute for the investigation of barbarian books) was founded and most of the Dutch books ended up in this institute together with the astronomical observatory. In 1863 it was renamed *kaiseijo*. In 1869 they moved to the newly established Imperial University, now The University of Tokyo, but according to Hayashi most of the Dutch books then became useless and found they use as waste paper, which he considered “a violent and inconsiderate proceeding”.[14]

Several Dutch works were translated into Japanese for educational purposes. Probably the first documented case is found in the medical science. Maeno Ryotaku (1723-1803), Sugita Gempaku (1733-1817) and three other scholars translated the *Ontleedkundige Tafelen* by Johann Adam Kulmus taking four years for the task. Their translation was published in 1774 under the title *Kaitai shinsho,* “New treatise on the anatomy of the body”.[15] Also some works on astronomy were translated from the Dutch: a book by J. Keill and one by de Lalande.[16] Nakayame, who studied these works, reports that all the mathematics was left out of de Lalande’s *Astronomy* because it was considered unintelligible.[17] Although translations of Dutch mathematical books would also find a significant audience, apparently they were not translated.[18] Hayashi, found in his own library, of which we now know this was a very extensive one, only three translations of Dutch books on mathematical sciences in its broadest sense. One on navigation by Jan Carel Pilaar, translated by Yuetsu Yanagi,[19] one on portable guns by Boom, and one on hurricanes by S. Van Delden, but originally from Henry Piddington who coined the term ‘cyclone’.[20] In a study on descriptive geometry, Hara informs us that several Dutch books on the subject were imported to Japan during the later Edo period.[21] They included *Handleiding tot het meetkundig teekenen* (A manual for geometrical drawings) by Jacob de Gelder (1823) and *Gronden der beschrijvende meetkunst* (Foundations of descriptive geometry) by H. Strootman (1841, 1847). Although engineering

[13] *Rangaku* is the study of Dutch language and in a broader sense Dutch learning or Western science. *Rangakusha* are a class of scholars who practiced *rangaku* often in heredity relations. These consisted of medical doctors, astronomers, gunnery instructors and mathematicians of the samurai class in service of feudal lords.

[14] The original collection of 3,500 books of the *Bansho shirabe-sho* were discovered after World War II in the warehouse of the Ueno Library and have been restored at the National Diet Library in Japan. They were first shown in a public exhibition in 1954, described by Jansen, M. B. “New Materials”. For an excellent online exhibition of material related to the institute see http://www.ndl.go.jp/nichiran/.

[15] Vos, F. *Van keurslijfjes en keesjes, bosschieters en lijfschutten: onze voorouders in Japan en Korea en het begin der Japanse en Koreaanse studiën in Nederland*, Universitaire Pers, Leiden, 1980.

[16] J. Keill, *Inleidinge tot de waare Natuur- en Sterrekunde*, Amsterdam, 1741, translated from the Latin by J. Luloffs; J.J.L de Lalande, *Astronomie der Sterrekunde*, 9 vols. Amsterdam, 1773-1790, translated from the French by Arnold B. Strabbe.

[17] Nakayama S. *A History of Japanese Astronomy*, Cambridge Ma.: Harvard University Press, 1969.

[18] Mori, T. “The social history of mathematics in Modern Japan”, (Translated from the Japanese and with notes by J. Fang), *Philosophia Mathematica* (1), 1981, p. 88-105.

[19] Hayashi, T. “How have the Japanese used the Dutch books” p. 47, writes “the original title of which is not known to me”. He probably refers to *Taisei suigun sohokan* (泰西・水軍操砲鑑). Jan Carel Pilaar wrote two books on navigation: *Handleiding tot de beschouwende en werkdadige stuurmanskunst*, Amsterdam: Gebroeders Van Cleef and C. van der Post, Jr., 1847, and *Handleiding tot de kennis van het tuig, de masten, zeilen, enz. van het schip*, Amsterdam: wed. G. Hulst Van Keulen, 1858.

[20] Hayashi mentions *Gesprekken over orkanen*, however the translation of Piddington’s books was S. van Delden, *Zeemans handboek over de stormen: Eene praktische verklaring der theorie van de wet der stormen en hare toepassing in alle gedeelten der wereld; door nuttige mededeelingen opgehelderd*, Amsterdam: Stemler, 1857.

[21] Hara, M. “Introduction of the education of descriptive geometry and engineering drawing in the later Tokugawa regime and early Meiji period”, (in Japanese), *Kagakusi Kenkyu*, Ser. II, 14 (115), 1975, p.104-117.

drawing was practiced in Japan at that time, Hara reports that these Dutch books were hardly used, let alone being translated.

In the same year that Hayashi's last note was published a new Japanese scholar enters the scene: Yoshio Mikami. In a contribution to the *Nieuw Archief voor Wiskunde*, he publishes a list with several corrections to Hayashi's history.[22] He also fills in on the details of two books mentioned by Hayashi. The two Japanese books which explicitly discuss Western arithmetic are:

- *Seisan Sokuchi* (西算速知, *A short course on Western Arithmetic* by Riken Fukuda, (edited by Hanai Kenkichi),1856.
- *Yōsan Yōhō* (洋算用法, *The method of Western arithmetic*) by Yanagawa Shunsan, 1857.[23]

In the same year, Mikami published two more notes on Dutch surveying.[24] They describe the contents of a manuscript *Kiku-jutzu denrai no maki*, compiled by multiple authors, about a surveying school in Nagasaki established during the seventeenth century by Higuchi Gonyemon who learned the art from a Dutchman. The identity of the Dutchman is not known but speculation is that the teacher was Kashuharu (probably Caspar Schambergen). Another Dutchman by the name of Peter Walius instructed Japanese surveyors from 1792 to 1796. Four books resulted from this surveying school:

- *Kiku buntō -shu* (規矩分等集) by Man-o Rokubei Tishun, (or Mao Tokiharu) Ogawa Hikokuro, 1722
- *Bundo yojutsu* (分度餘術) by Matsumiya Kanzan, 1723 (or 1728?)
- *Ryōcho shinan* (Treatise on land surveying) by Murai Shōkō, 1732, 1754 (or 1797)
- *Kiku-jutsu zukai* (An illustrated treatise on the art of surveying), Murata Sajūrō Kōryu, 1818

The Japanese rendering of Dutch words such as *kompasu* (kompas) in the *Ryōcho shinan* show the influence of the Dutch surveyors.

The case of Hartsingius

When discussing the influences of Dutch mathematics in Japan we cannot pass by on the case of Hartsingius. The idea that *wasan* may have been influenced by Dutch mathematics through Japanese students studying in Holland was first raised by Paul Harzer in an address to the German emperor and king of Preussen, Wilhelm II, for the occasion of his birthday on 27 January 1905. It was henceforth published in the yearly journal of German mathematicians.[25]

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[22] Mikami, Y. "Remarks on T. Hayashi's 'Brief History of Japanese Mathematics'" *Nieuw Archief voor Wiskunde* Serie **2,** 9, 1909, p.373-386.

[23] A facsimile of both books are published by Ohya Shin'ichi (1979) (Kochi Shuppan, Tokyo, 1979). A digital version of *Yōsan Yōhō* is available online from Waseda university library: http://archive.wul.waseda.ac.jp/kosho/ni02/ni02_02489/

[24] Mikami, (1909b) "On the Dutch art of surveying as studied in Japan", *Nieuw Archief voor Wiskunde*, Serie **2,** 9, 1909, p. 301-304. Mikami, (1909c) "Some additions to my paper 'On the Dutch art of surveying as studied in Japan'", *Nieuw Archief voor Wiskunde*, Serie **2**, 9, 1909, p. 370-371.

[25] Harzer, P. "Die exakten Wissenschaften im alten Japan", *Jahresbericht der Deutschen Mathematiker-Vereinigung*, 14, (6), 1905, p. 312-339. On p. 328 we read: "Daß die Japaner schon in dieser Zeit für die Bekanntschaft mit abendländischem Wissen nicht allein auf die Einfuhr der Holländer angewiesen waren,

In a note Harzer explains that the name of Hartsingius was first noted by Giovanna Vacca in the Van Schooten's Latin edition of Descartes *Geometry*. The reference to Hartsingius reads:

> Requiring greater certainty for the verification of this conjectured theorem, I proceeded to engage myself in exactly this question, instigated by an outstanding wise young man Petrus Hartsingius, from Japan, who previously devoted himself to mathematics as my most accomplished disciple.[26]

Vacca mentioned this to Moritz Cantor who communicated the news further to Harzer. Shortly after the lecture, Harzer found further confirmation from the Dutch historian Korteweg who located the matriculation records of Hartsingius. There are actually three, of which only the third one is cited by Harzer:[27]

- 29 Aug 1654, Petrus Hartsing, Japonensis, 20, P
- 28 Aug 1660, Petrus Hartsingius, Japonensis, 22, M
- 6 May 1669, Petrus Hartsingius, Japonensis, 31, M. Hon. C.

The letter 'M' stands for Medicin, 'P' for Philosophy and 'Hon. C.' for *honoris causa*. Apparently, Cantor had contacted Hayashi about Hartsingius who had answered that in Japan there is no trace to be found of that name. Hayashi hence took up the story himself and published an article about it in a Japanese journal.[28] In a note for *Biblioteca Mathematica* Mikami adds to the speculation. "If that Petrus Hartisingius did ever return to Japan, would it not be possible for him to have influence the progress of mathematics in his own country?".[29] In an attempt to succeed where Hayashi failed to trace the name within Japan, two years later he then puts forward the thesis that Hartsingius may be the same person as the physician Hatono Sōha, a student of Caspar in Nagasaki.[30] However, by comparing details on the dates of birth and death and the presupposition of cumulative conditionals he undermines his own thesis.[31]

Later, in their book on Japanese mathematics, Smith and Mikami reject the thesis of Hatono Sōha.[32] Their most important research question is "Did Seki and his contemporaries receive an impetus from the West?" and they get carried away on a full ten pages discussing the

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sondern, in allerdings wohl sehr seltenen Fällen, den Bann durchbrechend nach Europa selbst kamen, beweist uns die erhaltene Nachricht von einem jungen Japaner, der um 1650 in Leiden Mathematik studiert hat".

[26] Van Schooten, "placuit majoris certitudinis ergo idem theorema synthetice verificare, procenda à concesi ad quesita, prout ad hoc me instigavit praestantissimus ac undequaque doctissimus juvenis D. Petrus Hartsingius, Japonensis, quondam in addiscendis Mathematis discipulus meus solertissimus" my translation.

[27] Harzer P. "Die exakten Wissenschaften", footnote 24. Three records for the same person is rather unusual. Matriculation is normally done only once. The records are from: *Album studiosorum academiae Lugduno Batavae*, The Hague, 1875. Note that van Schooten's work was published posthumously in 1661, the year after his death.

[28] Hayashi, T. "On the Japanese who was in Europe".

[29] Mikami, Y. "Zur Frage abendländischer Einflüsse auf die japanische Mathematik am Ende des siebzehnten Jahrhunderts", *Bibliotheca Mathematica*, serie 3, 7, 1907, p. 364–366.

[30] Mikami, Y. "Hatono Sōha and the Mathematics of Seki", *Nieuw Archief voor Wiskunde*, serie **2**, 9, 1909, p. 158–171. On p. 159: "We know however of a person who wandered across the boundaries of the Japanese seas and returned about the same time when Petrus Hartsingius lived. He was a physisican, named Hatono Sōha".

[31] For example: Mikami, Y. "Hatono Sōha" p.162: "It is however certain that Hatono may have been in Holland before 1660, if he ever visited Europe".

[32] Smith, D. E. and Mikami Y. *A History of Japanese Mathematics*. Chicago: The Open Court Publishing, 1914. (New York: Dover books, 2004), p. 138.

possible influence of Hartsingius on Japanese mathematics.[33] Smith and Mikami also found the earlier matriculation data and one entry by other Japanese student:

- 4 September 1654, Franciscus Carron, Japonensis, 20, P

Not without some excitement, they believed to have come across an important line of influence from Western mathematics to the Seki mathematical tradition, quite the opposite from Van Schooten who praised the contributions by a Japanese student to problems of Descartes' *Geometry*:

> could the mathematics of the West, or any intimation of what was being accomplished by its devotees, have reached Japan in Seki's time? These questions are more easily asked than answered, but it is by no means improbable that the answers will come in due time. We have only recently had the problem stated, and the search for the solution has little more than just begun.[34]

They even suppose that they can locate where such influence may occur in Seki's work: "If Hatono or Hartsingius influenced Seki it must have been in the work on infinite series".[35] Such speculation inspired many Western historians, Florian Cajori added in his second edition of his *History of Mathematics*: "Probably some knowledge of European mathematics found its way into Japan in the seventeenth century".[36] Despite the rejection of the identification of Hartsingius and Sōha, Joseph Needham (1958, 11, note 15) takes up the story again: "A Japanese physician (Petrus Hartsingius Japonensis, perhaps identical with Hatono Sōha) studied in 17th century Leiden and managed to return to his own country".[37] Also later histories also identifies Hartingius with Hatono Sōha.[38]

In 1974 Peter van der Pas published an article which completely undermines all such speculation.[39] Independently from van der Pas, Andreas Baumann wrote a critical biography of Petrus Hartsingius providing several corrections and some additional data.[40] Some more information, such as a family tree and a translation of Hartsingius' testament surfaced through an article by Iwao Seiichi.[41] From these three independent studies we can reconstruct the whole story.[42] Petrus Hartsingius' father was named Karel Hartsinck. The family originated from Antwerp but moved to the German town of Moers after the fall of Antwerp in

[33] Ibid., p. 132-142.
[34] Ibid., p. 135.
[35] Ibid., p. 140.
[36] Cajori, F. *A History of Mathematics*, second, revised and enlarged edition, New York: Macmillan, 1919 (Chelsea Publications reprint, 1991), p. 81.
[37] Needham, J. *Science and Civilisation in China*, vol. 3, *Mathematics and the sciences of the heavens and the earth*, Cambridge: Cambridge University Press, 1958, p. 11, note 18.
[38] E.g. Hoffman J.E. Geschichte der Mathematik. Bonn: Athenäum Verlag, 1951, p. 141.
[39] van der Pas, P. W. "Japanese Students of Mathematics at the University of Leiden during the Sakoku Period", *Janus*, 61, p. 271-279. It was republished under the same title in Japan: van der Pas, P. W. "Japanese Students of Mathematics at the University of Leiden during the Sakoku Period", *Japanese Studies in the History of Science*, 14, pp. 109-116. Van der Pas collected books on the history of science and religion in the Far East. After his death in 2004, he left his collection of 3,100 volumes to the Nevada County Library.
[40] Bauman, A. H. "Petrus Hartsingius Japonensis, A Critical Biography", 大学院論集 (*Daigakuin Ronshu*), 10, 1991, p. 31-43.
[41] Seiichi, I. "The life of Pieter Hartsinck, The Japanner (1637-1680); 'Grand-pupil' of Descartes", *Transactions of the Asiatic Society of Japan*, Series **3**, 20, 1985, p. 145-67.
[42] We suppose these studies are independent from each other because none of the articles cite any of the others.

1585. Karel was born in Moers in 1611 and died in Batavia in 1667. From 1633 till 1637 he worked as a trader at the Dutch Trading Post of Hirado, near Nagasaki. One archival source, cited by van der Pas, lists 15 Oct 1633 as the date of birth of Pieter Hartsinck, the Latin epitaph at the St-Jacobi's church in Ostenrode, cited by Baumann and translated by Seiichi gives 15 Oct 1637. The matriculation record of 1660 at Leiden matches the first date and the 1669 record the latter date. Pieter was born from the Japanese wife of Karel, who gave birth to their second son Wilhelm on 12 July 1638. Van der Pas established that the '*Japonensis*' qualification in the Leiden University records thus only refers to place of birth. He also established that neither of the brothers ever returned to Japan. The fourth Sasoku edict of 1641 ordered the Dutch to leave Japan or to move to Deshima where the Portugese had left.[43] Baumann further gives 3 Nov 1641 as the data of departure of Karel and his two sons. His Japanese wife could not leave Japan under restrictions of the Sasoku edict. Karel sailed over Taiwan and Batavia in Indonesia and then to Holland. He married the widow Sara de Solemne (1619-1695) during their trip. [44] They arrived in Holland in July 1643 and later lived in Moers.[45] As we know, Pieter Hartsinck enrolled in Leiden in the summer of 1654. Baumann found him also registered at Duisburg University on 1 Nov 1655 for mathematics, physics and metaphysics. When completing his studies in Leiden after 1560 he moved to Amsterdam to take part in a trading company involved in mining. He lived most of the rest of his life in Germany where he died in 1680. As Pieter Hartsinck was in Japan only as a toddler – or, if born in 1633, as a young schoolboy – it is unlikely that he influenced Seki's work on infinite series!

Franciscus Caron is even less likely to have influenced *wasan*. As we learn from van der Pas (1975), Franciscus was the son of François Caron, a director at the Dutch East India Company and his Japanese wife.[46] Franciscus was born at Hirado in 1634 and left with his father to Holland, also in 1641. He started his studies in Leiden in 1654, but moved to the University of Utrecht the year after.[47] He became a clergyman and wrote some religious texts. He never returned to Japan and died in Holland in 1706.

The nineteenth century

Before the second half of the nineteenth century the influence of Dutch mathematics in Japan, if any, must have been very limited. Mikami summarizes the situation as follows:[48]

> Some of the mathematicians in the first part of the 19th century were able to read Dutch works, though their knowledge of the language was of an exceedingly limited kind. A certain number of Dutch astronomical works were possessed by the Astronomical Board of the Shogunate, but we know practically nothing of what were the mathematical treatises brought from Holland to Japan in those days. Nor are we able to find traces of the Dutch

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[43] For a recent overview of these edicts and their impact see Laver, M. S., *The Sakoku Edicts and the Politics of Tokugawa Hegemony*. Cambria Press: New York, 2010. Deshima was an artificial island at the port of Nagasaki where the Dutch stayed until the Meiji restoration.

[44] Baumann gives 1642 for their year of marriage but no place. Seiichi, I. "The life of Pieter Hartsinck" writes they married after their return to Germany. Wijnaendts van Resandt, in a history of the East-indian company writes that they married about 1641 or 1642 at Formosa (Taiwan), Wijnaendts van Resandt, W., *De gezaghebbers der Oost-Indische Compagnie op hare buiten-comptoiren in Azië*. Amsterdam: Genealogische bibliotheek 2, 1944, p. 298.

[45] Seiichi, I. "The life of Pieter Hartsinck" lists the date of return.

[46] van der Pas, P. W. "Japanese Students".

[47] Vos, F. *Van keurslijfjes en keesjes*, concludes from this that he must have been underperforming as a student.

[48] Mikami, Y. *The development of mathematics in China and Japan*, Leipzig: Teubner, 1913, p. 177-178.

influence upon the writings belonging to this epoch. No quotations, no references are found. The relation of the Dutch science and the mathematics cultivated in Japan still remains unexplored. It is almost the whole of the Dutch influence, of which we know, that some of the writings of Kawai [Kyotoku, Kaishiki Shinpō, 開式新法], Shiraishi, Ichino [Mokyo] and others contain some deformed Roman characters as symbols. Reflecting on the incorrectness with which the names of the authors are spelled, their knowledge learned from Dutch works appears to have been very limited if any. We have no knowledge of any Occidentalist, who was at the same time a mathematician.

The situation changed dramatically on the arrival of commodore Matthew C. Perry with a flotilla of four warships at Uraga Harbor on July 1853. His insistence on forcing the opening of Japan had a dramatic threatening effect on the shogunate. Several actions were taken as a response including the fortification of coastal areas such as Tokyo bay. On 7 August a messenger was sent to the Dutch *opperhoofd* (chief merchant) at Deshima with two questions: what is the cost of a frigate and steam warship and can the Dutch deliver these?[49] An approximate answer was given to the first question and he was told that an answer to the second required the consultation with the Dutch government. They were told that it could take up to three years before such ships would be delivered to Japan. On 15 October the governors of Nagasaki communicated the decision by the Edo government to found a naval force according to Western principles and asked the Dutch for help. The Dutch responded with a list of demands in order to assist them in that. However, they made clear from the beginning that it makes no sense to deliver Western frigates without the proper training of Japanese naval officers. The proposal by the last *opperhoofd* Donker Curtius of sending Japanese youths to Holland for an intensive training program was declined with an unambiguous warning not to raise this delicate topic again. Instead, it was chosen to train Japanese naval officers near Deshima. The Dutch delivered a list of subjects that needed to be taught to the new officers by Dutch military teachers. They listed 14 disciplines, putting the mathematical courses on top:[50]

1. Geography and navigation according to Western principles using European maps
2. Astronomy
3. Arithmetic according to the Western method
4. Algebra (*stelkunst*)
5. Geometry
6. …

continuing with crafts specific to naval and military expertise. The answer to the Japanese stressed the fact that "war ships carrying officers and personnel without experience in these disciplines would lead to a disadvantage rather than be of any use". A clearer statement of the utility of Western mathematics to modern warfare will be hard to find. The motivation to establish the *Bansho shirabe-sho* in 1856 should also be seen in direct relevance to the

[49] We here closely follow the Dutch account published as "History of the Dutch marine detachment in Japan", by Van der Chijs, J.A. *Neêrlands streven tot openstelling van Japan voor den wereldhandel: Uit officieele, grootendeels onuitgegeven bescheiden toegelicht*, Amsterdam: Frederik Muller, 1867, p. 414-498, including Dutch translation of the official Japanese documents.

[50] Translated from the official notes of 15 Oct 1853, van der Chijs, *Neêrlands streven*, p. 415-416. For a discussion of the other courses, related to navigation and military science, see Arima, S. (1964) "The Western Influence on Japanese Military Science, Shipbuilding, and Navigation", *Monumenta Nipponica*, **19**, (3-4), 1964, p. 352-379.

military threat. The Dutch were considered instrumental in the acquisition of Western knowledge necessary for a defense. Thomas C. Smith quotes one Mito official who stated in 1854 that "the necessity of defense against the barbarians requires that we know them and know ourselves; there is no other way to know them than trough Dutch learning".[51]

After months of negotiation the paddle steamers *Soembing* and *Gedeh* were sent to Japan lead by captain Gerhardus Fabius. The *Soembing* arrived at Nagasaki on 22 August 1854 under the command of Gerhard Christiaan Coenraad Pels Rijcken, the *Gedeh* on 21 July 1855. The *Soembing* was equipped with six big guns. It functioned as the training ship for the newly established Nagasaki *Kaigun Denshu-sho* (Nagasaki naval school). The *Soembing* was handed over to Japanese authorities on 5 October 1855. Dozens of young samurai were sent to Nagasaki by the shogunate to be trained as naval officers. Several had already some experience with Dutch as *rangakusha*. Some of the students we know by name and became important to the Japanese naval command. Kaishu Katsu (勝 海舟, 1823 – 1899) had studied European military science from Dutch books. He was assigned the command of the *Kanrin-maru* in 1860 and became a statesman. Utida Tsunejirō became a naval commander. Horie Kuwajirō (堀江 鍬次郎, 1831 – 1866) had studied chemistry from Dutch text books and became one of Japan's earliest photographers. Other students include Matsumoto Ryojun who studied Dutch medicine. Some student of the naval school were sent to the Netherlands from 1862 such as Enomoto Takeaki (榎本武揚, 1836 – 1908) Uchida Masao (Kojirō, 1839-1876) who worked at the *Kaisejo* after his return in 1867 and Akamatsu Noriyoshi (Daizaburo, 1841-1920) who became Vice Admiral.[52]

Classes commenced on board of the *Soembing* in the bay of Nagasaki on 24 Oct 1855 and lasted until May 1859 when the institute was moved to Tsukiji.[53] The Dutch officers were lodged on Deshima but could freely move around Nagasaki by the end of 1855. Pels Rijcken was responsible for the training program until another screw-driven steam warship, the *Kanrin maru*, was delivered by a second detachment on 21 Sept 1857. Its commander Willem Johan Cornelis Huyssen van Kattendycke took over on 1 Nov for the following two years. Both commanders were themselves involved in teaching. Pels Rijcken taught navigation, cannonry and mensuration. Other instructors included Cornelis Hendrikus Parker de Jonge, the physician dr. Jan Karel Van den Broek, H. O. Wichers (2nd class officer) teaching geometry, algebra, trigonometry, navigation (part I), and from 1958 also descriptive geometry. C.J. Umbgrove (3rd class officer) was teaching "arithmetic in whole and broken numbers, proportions and root extraction". Several witness accounts of the training program by Dutch officers have been preserved. W.J.C. Huyssen van Kattendycke kept a diary from which extracts have been published in 1860.[54] Van den Broek (1862) wrote a flaming response, revealing much of the sensitivities and rivalries of the first detachment.[55] The naval doctor J.C.L. Pompe van Meerdervoort kept notes during his five year stay in Japan and as such provides the most extensive witness account of life at Deshima during that period. He

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[51] Smith, T. C. "The Introduction of Western Industry to Japan during the Last Years of the Tokugawa Period", *Harvard Journal of Asiatic Studies*, **11** (1/2), 1948, p. 130-152, quoted from p. 131.
[52] These names appear on a roll kept at the National Diet Library, Japan, ms. 93 in the Katsu Kaishu manuscript collection.
[53] Some sources, such as Arima, S. (1964) "The Western Influence", give Feb 1859 as the end of the Nagasaki naval school. This does not fit with the Dutch records.
[54] Huyssen van Kattendijke, W.J.C. *Uittreksel uit het dagboek van W.J.C. Ridder Huyssen van Kattendijke, gedurende zijn verblijf in Japan in 1857, 1858 en 1859*, 'S Gravenhage: W.P. van Stockum, 1860.
[55] Van den Broek, K.J. "Nederland en Japan. Kantteekeningen bij officieusen tekst", *De Tijdspiegel*, 1862, 126-135.

taught medicine to 150 students of which 61 graduated as medical doctors in 1862. His account of Japan, based on his notes, was published in a two-volume book.[56] H. O. Wichers kept a diary from 1857 to 1859, which remains unpublished but preserved at the museum of the Dutch Navy in The Hague.[57] He became a Dutch marine minister in 1877. Van Kattendycke lists some details on the mathematics courses.[58] Teaching was done through the aid of interpreters. However, the Dutch complained that they did not understand their language enough and that they had problems with translating the technical terms. Geometry and algebra were taught 5 hours per week by a 2nd class lieutenant. Arithmetic was taught for 9 hours per week by an administration officer.

Van Kattendycke was at first skeptical about the assignment: "Pompe's teaching could be brought to direct use, by the treatment of diseases in Nagasaki, but algebra and navigation, or put differently, everything related to mathematics, what could be expected from that?".[59] We also should take into account the social structure of Edo intellectual culture. Mathematics exemplified the divide between *samurai* and *chonin* (merchant) cultures. Smith and Mikami note that "samurai despised the plebeian soroban, and the guild of learning sympathized with this attitude of mind".[60] As abbaco arithmetic and algebra were associated with the merchant class in sixteenth-century Europe, so it was during the Edo period. Rikitaro Fujisawa in a comprehensive report on mathematics education in Japan writes that "The intellectual education was essentiality classical in nature, and profoundly influenced by the Confucianism tinged with the chivalrous spirit of feudal times. To do such things as calculation was thought condescending beneath the dignity of the samurai rank. They even went to the length of boasting of their ignorance in the art of computation practiced by trades-folk".[61] This does not mean that the samurai class detested mathematics – as there were samurai mathematicians – but the esthetics of *sangaku* appealed more to their intellectual aspirations than the practicalities of merchant arithmetic.[62] So it must have been a culture shock for students from the samurai class to get confronted with down-to-earth calculations which they associated with merchant arithmetic. The direct relevance of this to naval warfare was not always clear and posed a motivation problem.

The first year was difficult as we read from a report by Pels Rijcken: "Without a soroban they were not able to make the most elementary calculations".[63] Students were afraid to ask questions, even when they did not fully understood what was being taught. When the

[56] Pompe van Meerdervoort, J.C.L. *Vijf Jaren in Japan (1857 - 1863) Bijdragen tot de kennis van het Japansche Keizerrijk en zijne bevolking.* Van den Heuvel en Van Santen, Leiden (2 vols.), 1867, 1868. The book is translated into English and Japanese. He also published some medical studies related to his stay in Japan: Pompe van Meerdervoort, J.C.L. "Verslag over de gouvernements geneeskundige dienst op het eiland desima en in Japan, over 1857 en 1858", *Geneeskundig tijdschrift voor Nederlandsch Indie*, Lange en Co., Batavia,1859, pp. 495-572. 3 cholera epidemics in Japan, 1858-1859-1862: a description, Leiden: De Baaierd, 1998. His *Korte beschouwing der pokziekte en hare wijzigingen* was translated in Japanese by Mitsukuri Genpo but never printed.
[57] Instituut Voor Maritieme Historie, "Dagboek verblijf in Japan als instructeur Japanse marine", 1857 – 1859, Inventaris van de losse stukken, archive nr. 266.
[58] Huyssen van Kattendijke, W.J.C. *Uittreksel uit het dagboek*, p. 23.
[59] Ibid, p. 73.
[60] Smith, D. E. and Mikami Y. *A History of Japanese Mathematics*, p. 46.
[61] Fujisawa R., *Summary Report on the Teaching of Mathematics in Japan*, Tokyo: International Commission on the Teaching of Mathematics, 1912, p. 22.
[62] *Sangaku* are intricate geometrical problems from the Edo period which were often displayed at the entrance shrines and temples. See Fukagawa, H. and Rothman, T. *Sacred mathematics: Japanese temple geometry*, Princeton NJ.: Princeton University Press, 2008, for an excellent work in English on this tradition.
[63] Van der Chijs, J.A. *Neêrlands streven*, p. 462.

Japanese students met with the teaching officers outside of the classroom, which was encouraged, they were more frank and asked more questions.[64] After several weeks, on 8 Dec 1855 the courses were reorganized and the conditions improved. More attention was now given to the teaching of Dutch language and basic arithmetic. After a year most of the students mastered the basic of mathematics in Western style.[65] They could operate on numbers, solve the more difficult arithmetical problems and use algebra. They could solve linear problem with several unknowns, solve quadratic equations and use logarithms with ease. Those who had done algebra were also taught solid geometry and from Oct 1856 onwards plane and spherical trigonometry. All these students could read Dutch texts and consulted Dutch text books. In the early morning of 29 March 1857 the *Soembing*, in Japanese renamed as *Kanko Maru* (光丸) was put under steam and sailed off to Tokyo manned by 105 Japanese crew, all of them had followed 15 months of training by the Dutch. In April lessons resumed for the students who were left behind together with the new arrivals. In March 1859 the Dutch were surprised and the students disappointed to hear that the operations of the naval school would be moved to Edo.[66] The move took place in May and all teaching on Nagasaki became officially ended. However, some students still followed lessons at Deshima until the second detachment left on 4 Nov 1859.

The first Japanese works on Western mathematics

The *Seisan Sokuchi* (*A short course on Western Arithmetic*) by Riken Fukuda published in 1856 and the *Yōsan Yōhō* (*The method of Western arithmetic*) by Yanagawa Shunsan in 1857, listed by Mikami indeed were the first Japanese works describing Western style arithmetic. It is not clear to what degree the appearance of these books is related to two new established institutes. However, several facts point into such direction. First note that the publication dates coincide with the establishment of the *Bansho shirabe-sho* institute. The idea of such institute was suggested by Katsu Kaishu to Abe Masahiro.[67] Katsu, one of the students of the naval school, was later also involved with the selection of subjects for study and translation by the institute.[68] The overlap in subjects taught by at the *Kaigun Denshu-sho* is remarkable. Also, the 575 books used by the Dutch ended up in the library of the *Bansho shirabe-sho*.[69]

Not only did the Dutch arithmetic books spread, but the very teaching of arithmetic went beyond the direct needs of the naval training school. Van Kattendycke reports that following a suggestion by Donker Curtius, also a class of 25 to 30 children of translators between 8 and 15, were taught the basics of arithmetic. However, this project was abandoned after a fire on Deshima (on 7-8 March 1858).[70] The interest of the Dutch in Japanese mathematics and science also went beyond the practical needs for organizing training. Donker Curtius collected about hundred thirty books authored by *rangakusha* during his stay in Japan.[71] He

[64] Private teaching by the Dutch officers became more the rule than an exception in 1858 as reported in Van der Chijs, J.A. *Neêrlands streven*, p. 488.
[65] Ibid. p. 465.
[66] Ibid. 489-490.
[67] Jansen, Marius B. "New Materials".
[68] Hommes, J. M. The *Bansho shirabesho*: *A Transitional Institution in Bakumatsu Japan*. Bachelor thesis. University of Pittsburg, 1993, p. 33.
[69] Ibid., p. 76-77.
[70] Huyssen van Kattendijke, W.J.C. *Uittreksel uit het dagboek*, p. 74. The story is confirmed by Van der Chijs, J.A. *Neêrlands streven*, p. 483.
[71] In this he followed the German physician Philipp Franz von Siebold (1769 - 1866) who stayed at Deshima from 1823 to 1830, who already brought a large collection of Japanese books and manuscripts (together with paintings, instruments etc.) to Europe. The items are described by J. Hoffmann, *Catalogus librorum et*

owned a copy of *Yōsan Yōhō* (nr. 60 in the *Catalogue* by Serrurier, 1879) as well as a copy of *Seisan Sokuchi* (catalogue nr. 62a).[72] These are the only works on European mathematics in his collection and probably the only works in this category at that time. In 1861 he sold his books to the Dutch government and the collection is now kept at Leiden University Library.[73] One medical instructor of the first detachment, Van den Broek, collected 27 rare manuscripts and books by *rangakusha* which were only recently rediscovered by Herman J. Moeshart at the Library of Arhem in Holland.[74] Both had a reasonable knowledge of the Japanese language. Donker Curtius dispatched a manuscript on Japanese grammar already in 1855 to Hoffmann, who was then a professor of Japanese at Leiden. Van den Broek, who felt sabotaged in his plans to publish his own dictionary, complained about the manuscript that "words were spelled so poorly that it was of no use at all".[75] Hoffmann spent considerable effort to improve it to a publishable work.[76] Apparently there was a demand for Japanese dictionaries and grammars as it was soon adapted to French.[77] The least we can conclude from this is that the interest of the Dutch and Japanese in the other's language and knowledge was a mutual one.

Before we look at the two works in detail let us remind us the unique historical conditions under which the books appeared. As Sasaki has pointed out at several occasions, evolutions in mathematics are best understood from the social history in which they occur.[78] The *sakoku* policy already provided us with almost experimental conditions for the study on the contingency of mathematics: does the development of mathematics follow some intrinsically logical path or is it determined by the social, economical and political conditions of the society in which it is practiced? The relative isolation of the development of Japanese mathematics during the Edo period makes this the best case for such a study. However, the answer for Japanese *wasan* is not that easy and falls beyond the scope of this paper, but both aspects have been present in its development.[79] *Wasan* practitioners did parallel certain important developments independently from the West. The most salient ones are the development of *bōshohō* ("side-writing", a kind of symbolism in algebra), the foundations of infinitesimal calculus and Seki's work on infinite series which baffled Smith and Mikami. On the other hand, the complete lack of mathematics in the study of the physical world, the specific esthetics of *sangaku* problems and the modes of proof and demonstration are some of

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manuscriptorum Japonicorum a eo collect. annexa enumeration illorum, qui in Museo Regio Hagano servantur. Leiden, 1845.

[72] Serrurier, L. (1882) *Verzameling van Japanse boekwerken door mr. J.H. Donker Curtius, Nederlands Commissaris in Japan, op zijne reid naar Yedo in 1858 voor het rijk ingekocht. Beschreven door wijlen dr. J.J. Hoffmann*, Leiden: Leiden University Library.

[73] Kerlen H. *Catalogue of pre-Meiji Japanese books and maps in public collections in the Netherlands*, Japan Neerlandica 6, Amsterdam: J.C. Gieben, 1996.

[74] Moeshart, H. J. *Guide & Concordance To Nineteenth-century Dutch/Japanese Japanese/Dutch Manuscript Dictionaries and Related Documents: The J .K. Van Den Broek Collection*, Arnhem: Arnhem City Library, Gelderland Documentation Centre, 2003.

[75] Van den Broek, K.J. "Nederland en Japan", p. 133.

[76] Donker Curtius J. H. *Proeve eener Japansche spraakkunst, toegelicht, verbeterd en met uitgebreide bijvoegselen vermeerderd door dr. J. Hoffmann*, Leiden: A. W. Sythoff, 1857.

[77] Pages, L. (ed. tr.) *Essai de grammaire japonaise composé par M.J.H. Donker Curtius, enrichi d'éclaircissements et d'additions nombreuses par M.J. Hoffman*, Paris: Remquet, Coupy et Cie, 1861.

[78] See Sasaki, C. "The Emergence of the Japanese Mathematical Community", and Sasaki, C. "Asian Mathematics from Traditional to Modern", *Historia Scientiarum*, 4, (2), 1994, p. 69-77.

[79] The most comprehensive overview of wasan in a Western language is Horiuchi, A. (1994). *Les Mathematiques Japonaises a L'Epoque d'Edo (1600–1868): Une Etude des Travaux de Seki Takakazu (?-1708) et de Takebe Katahiro (1664–1739).* Paris: Librairie Philosophique J. Vrin, recently translated into English: *Japanese Mathematics in the Edo Period (1600-1868. A Study of the Works of Seki Takakazu (?-1708) and Takebe Katahiro (1664-1739),* Science Networks. Historical Studies, Vol. 40, Basel: Birkhauser, 2010.

the idiosyncrasies which can best be explained within the context of the Edo society.[80] The Kanagawa treaty of 1854 effectively ended two centuries of seclusion policy and is as interesting as an experiment as the closure of Japan: What is the best way to introduce *yōzan* or Western science and mathematics to Japan? As a comparison with Europe, the transition from Roman numerals and calculation with the Gerbertian abacus to the use of Hindu-Arabic numerals took several centuries. In Japan, the transition from *wasan* to *yōzan* was an even more drastic one and took only some decades to accomplish. The choice for such drastic reform was undoubtedly inspired by the military threat and part of the transformation of the *bakufu* and *samurai* culture to a modern Japan.

Let us now have a closer look at the two Japanese works and how they relate to Dutch works on arithmetic.[81] It seems that there were two options for a Japanese author of a book on Western mathematics in 1855. Either you approach it from the *wasan* tradition and explain how Western mathematics functions different and relates to existing methods and practices. The other approach is that of a *rangakusha* with respect for the original language, terminology and presentation of the Western works. Both these books represent one of these options. From a first comparison it becomes clear that the *Seisan Sokuchi* is more integrated with *wasan* than the *Yōsan Yōhō* is. The author of the first, Riken Fukuda (1815-1889) of Osaka, was a *wasan* scholar and he made a considerable effort to integrate Western methods of arithmetic with existing *wasan* knowledge of mathematics. Western numerals and signs for operations are completely absent from the book. Multiplication tables, to be found in every elementary work on arithmetic since Fibonacci's *Liber abbaci*, are presented in the *Seisan Sokuchi* with Japanese numerals. In the *Yōsan Yōhō,* on the other hand, Hindu-Arabic numerals feature prominently in the first section on numeration.[82] Yanagawa Shunsan (柳川春三, 1832-1870) was from a very different background. [83] He was the son of a tool maker in Nagoya who studied literary Chinese and Dutch at a young age and was reputed for his calligraphy. He moved to Edo and Nagasaki where he worked as a *rangakusha*. In 1861 he moved to the Kaiseijo translation bureau in. Like Horie Kuwajirō, he was interested in photography. In 1864 he was appointed teacher at the Kaiseijo and became publisher of the Shimbun Kaisō. In 1867 he founded *Seiyō Zasshi*, the first Japanese periodical. In 1868 he became the head of the *Kaiseijo*. Yanagawa also published a Japanese edition of a Chinese translation of a work on Western learning *Zhihuan qimeng* (Elementary lessons in the circle of knowledge) in 1862.[84]

A salient aspect of Yanagawa's book is that throughout the Dutch pronunciation of operations is added in Katakana. Such a practice has no function at all for learning Western arithmetic unless … the teaching would be in Dutch, or it is intended for *rangakusha* with

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[80] For one of the few studies on the relation of wasan and physics see Ravina. M. "Wasan and the Physics that Wasn't. Mathematics in the Tokugawa Period", *Monumenta Nipponica*, **48**, 2, (Summer, 1993), p. 205-224.
[81] For a modern facsimile edition see Shin'ichi, O. (ed.) *Seisan sokuchi,* , Tokyo: Kochi Shuppan, 1979.
[82] Yanagawa Shunsan, *Yōsan Yōhō*, 1857, p. 9a. All references refer to the original edition counting from the title page as 1a, 1b, 2a ...
[83] These biographical data are based on Munson, T.S. "The Procurement of Rarities is a Sign of Peace: Ideological Resistance to Imperialism in Yanagawa Shunsan's *Yokohama hanjoki*," in *Early Modern Japan: An Interdisciplinary Journal*, 13, 2005, p. 1-10. There is also a Japanese biography of Yanagawa: Osatake Tateki, *Shinbun zasshi no soshisha Yanagawa Shunsan* (*Yanagawa Shunsan, Founder of a Newspaper and a Magazine*), Tokyo: Takayama shoten, 1940 (not consulted).
[84] Liu Jianhui, *Mato Shanhai: Nihon chishikijin no "kindai" taiken* (Tokyo: Kōdansha, 2000), pp. 94-127. Translated by Fogel, J. A. "Demon Capital Shanghai: The "Modern" Experience of Japanese Intellectuals", *Sino-Japanese Studies*, 16, 2009, p. 126-145.

some knowledge of Dutch. After numeration it is explained how whole and broken are to be pronounced.[85] This approach runs easily into problems as language conventions do not follow the rules of arithmetic. For example, the number 321 is pronounced in Dutch 'driehonderdéénentwintig' and is in an order different from English or Japanese. It would sound as "three hundred one and twenty". As this would present difficulties, in the book this example is rendered as 3 hundreds, 2 tens and 1 ones.[86]

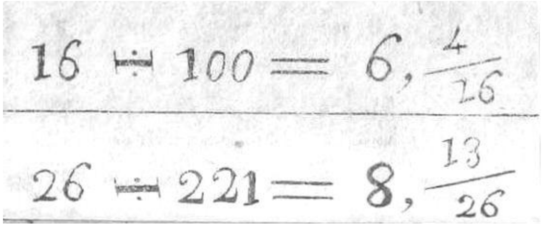

Figure 1: division in the *Yōsan Yōhō*

Also differences in writing conventions between European languages and Japanese pose problems. As shown in Figure 1, this representation of division would be correct if you read it from right to left: 6 4/26 is the result of dividing 100 by 16. However, if it is read from the left to the right (or top to bottom as it appears in the book) the statement 16 ÷ 100 = 6, 4/16 would be wrong.[87] The use of a comma is also puzzling. While the comma is used as a decimal point, the combination of the comma and fractions does never appear in Dutch arithmetic books.

Not only are the Dutch pronunciations of numbers up to a million discussed also the multiplication tables are transliterated as if they were drilled in Dutch. We find in the book the katakana for "één maal één is één", "twee maal twee is vier", "twee maal drie is zes", "drie maal drie is negen", "acht maal negen is tweeënzeventig" and "negen maal negen is éénentachtig" (respectively the products 1 × 1, 2 × 2, 2 × 3, 3 × 3, 8 × 9, 9 × 9). Again, the Dutch pronunciation of such tables is irrelevant for learning Western arithmetic unless it is intended to be taught in Dutch. The Dutch names for basic operations of arithmetic and terms such as 'fractions', 'equality' and so on are given in katakana as well as.[88] One specific term in the long list is peculiar. 'Eigenlijdigheid' as such is not a Dutch word. It is derived from the uncommon term 'eigenlijdig' which was used only in the medical sense, meaning the local illness of body part which does not affect the other parts.[89] Its use in a book on arithmetic is surprising and might reveal some familiarity of the author with Dutch medical literature.

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[85] Yanagawa Shunsan, *Yōsan Yōhō*, 1857, p. 11a.
[86] Ibid. p. 11b.
[87] Ibid. p. 12a.
[88] For a discussion of these terms and their use for the official "Government course guidelines for elementary school, Arithmetic" issued later see Kiyosi, Yamaguti, 三"洋算用法"における蘭和数学用語記号について (On Mathematical Terms and Notations in Dutch and Japanese in the "Yosan Yoho" or Usage of Western Arithmetic) (1857) Shunsan Yanagawa) *Journal of the Faculty of International Studies of Culture, Kyushu Sangyo University*, 5, 1996, p. 137-152.
[89] According to the historical dictionary *Woordenboek der Nederlandse Taal*.

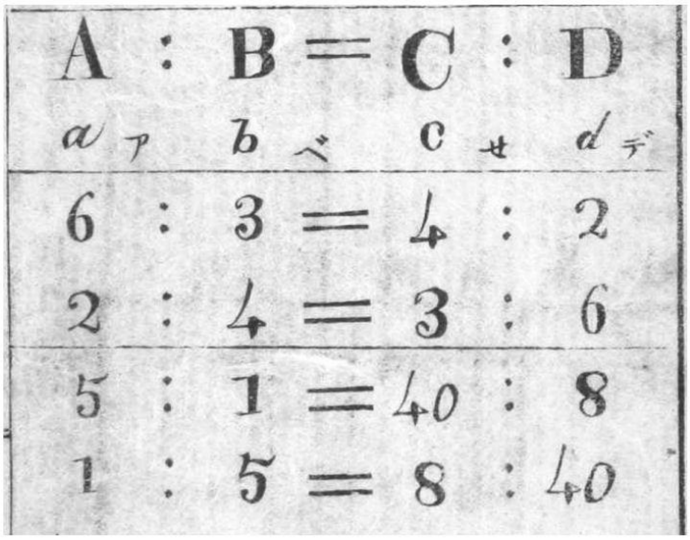

Figure 2: proportions in the *Yōsan Yōhō*

The faithful rendering of Dutch arithmetic in the *Yōsan Yōhō* had the advantage that Western symbolism was introduced at this early stage. Figure 2 shows the notation for proportions in with the use of letters A : B = C : D, which are transliterated in katakana.[90] The book is probably the first Japanese work to use the symbol *x* for the unknown, in relation to proportions: $a : b = c : x$.[91] The choice for using Western symbols was a deliberate one as we read from the introduction. Complaining about the lack of systematization of *wasan* authors he writes: "People find [occidental calculation] difficult to learn because they do not retain the Dutch ciphers. But in fact it is much easier to understand than to operate the soroban and saves us a lot the trouble of memorization".[92] He is possibly referring to the *Seisan Sokuchi* which did not retain the symbolism of Dutch arithmetic. Also interesting is that Yanagawa compares the symbols for the unknown *x*, *y*, *z* with ideograms as shown in Figure 3.[93]

A comparison of the *Yōsan Yōhō* with several Dutch arithmetic books from Hayashi's list does not reveal any direct source.[94] In all probability, Yanagawa's book is not a translation of a Dutch book on arithmetic but rather a commentary or a collection of notes on Dutch arithmetic. The notes may have been collected while consulting Dutch arithmetic books but it might also possible that these were based on the lessons that were taught at the Nagasaki naval school. We have already situated the book in a context where knowledge of Dutch

[90] Yanagawa Shunsan, *Yōsan Yōhō*, 1857, p. 27b.
[91] Ibid. p. 15a.
[92] Translated from the French from Horiuchi," Sur la recomposition du passage mathématique japonais au début de l'epoque Meiji", in Goldstein, C., Gray, J ; and Ritter J. *L'Europe mathématique: histoires, mythes, identités*, Paris : Fondation Maison des sciences de l'homme, 1996, p. 247- 270, quoted from p. 260.
[93] Yanagawa Shunsan, *Yōsan Yōhō*, 1857, p. 8a.
[94] Hayashi, T. "A list of Dutch books". In particular we looked at the arithmetical works: de Gelder, J. *Allereerste gronden der cijferkunst*, s'Gravenhage en Amsterdam: Gebr. van Cleef, 1824; Wiskundig Genootschap, *Verzameling van nieuwe wiskundige voorstellen,* Amsterdam: Weijtingh en Van der Haart, vol. 1: 1820, vol. 2: 1846; and the elementary algebra by J. Badon Ghijben, H. Strootman, *Beginselen der Stelkunst, bevattende: De bebandeling der stelkunstige vormen , de oplossing der vergelijkingen van den eersten en tweeden graad, De treorien der gewone logarithmen, reken –en meetkunstige reeksen en kogelstapels*. Breda: Koninklijke Militaire Academie, 1840 (2nd ed.).

terms for operations is important and the use of Dutch phrases to memorize multiplication tables. Another indication is the kind of problems we find treated in the book:[95]

> One battle ship in Germany has 80 guns and 2000 crew members. One frigate has 36 guns and 600 crews. How many guns and crew members do five battle ships and 10 frigates have?

With Huyssen van Kattendyke complaining that his Japanese students could not always appreciate the relevance of arithmetic and algebra for the art of navigation, it makes sense to set arithmetical problems within the practical context of naval warfare.[96]

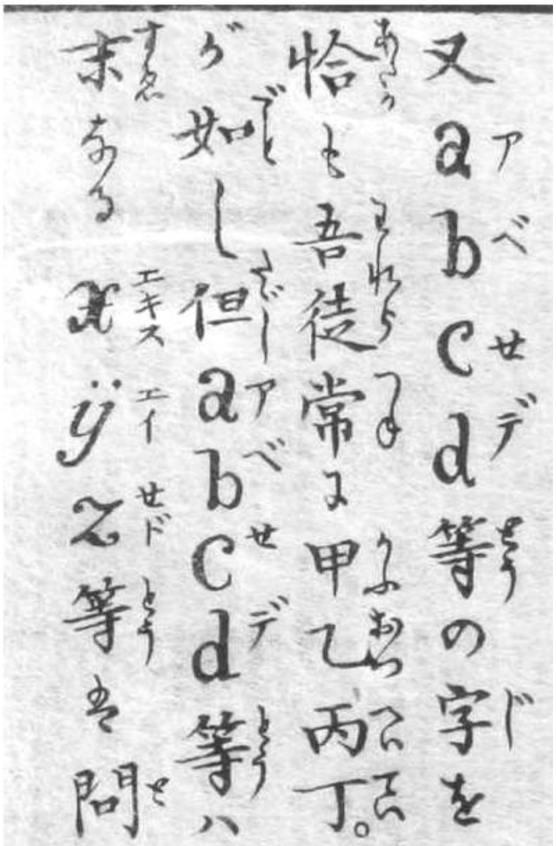

Figure 3: the introduction of literal symbolism in the *Yōsan Yōhō*

It comes as no surprise that there is a strong parallel between the educational philosophy of the Nagasaki naval school – and consequently early Meiji education – with what Danny Beckers has called the 'propaedeutic function of mathematics' in the Netherlands during the first half of the nineteenth century.[97] Despite the strong emphasis on mathematics in the Nagasaki naval training program, the intention was not to create able mathematicians but to use mathematics as a basis to transform the samurai mind to modern Western thinking and

[95] Yanagawa Shunsan, *Yōsan Yōhō*, 1857, p. 34b?. The problem is quoted by Shigeru, J. "The Dawn of Wasan (Japanese Mathematics)", in H. Selin, U. d'Ambrosio, *Mathematics Across Cultures: the History of Non-Western Mathematics*, Dordrecht: Kluwer Academic, 2000, p. 423-454, p. 446.
[96] Huyssen van Kattendijke, W.J.C. *Uittreksel uit het dagboek*. We have no evidence that this problem is derived from the *Kaigun Denshu-sho* but as the available Dutch books do not contain such examples and its first appearance in a book of 1857 while the lessons took place in Nagasaki makes a connection very likely.
[97] Beckers, D. *"Het despotisme der mathesis", Opkomst van de propaedeutische functie van de wiskunde in Nederland 1750-1850,* (Dutch) Ph.D. Dissertation, Nijmegen University 2003.

learning. The main proponents of the new educational program in Holland at that time were the Leyden professor Jacob de Gelder, I.R. Schmidt and Rehuel Lobatto from the Delft polytechnic school and J. Badon Ghijben en H. Strootman from the Breda military academy. These mathematicians produced the textbooks we find used in Japan during the 1850's and trained the teachers of the Nagasaki naval school.[98] Beckers describes the rise of the propaedeutic function of mathematics as "the successful mix of belief in progress, educational ideas and the rise of modern nations" which thus provides the best fit for the needs of the new Meiji era of the Japanese society.[99] If indeed we may attribute such important influence of the Dutch to education in Japan of the early Meiji period, the relevance of Holland, the Dutch language and *rangaku* soon evaporated. While some students of the naval school were sent to Holland for further study, together with instructors of the *Bansho shirabe-sho* such as Nishi Amane and Tsuda Mamichi, they soon found out that the Dutch language was of minor importance in the intellectual, cultural and political centers of the West. Jansen reports that Matsuki Kōan of the institute complained that he could hardly find any Dutch books and that the "Hollanders themselves all read their books in French and German".[100] With the opening of Japan, two centuries of *rangaku* came to an end and English, French and German books soon replaced the Dutch works as sources of Western learning.

Conclusion

The history of Japanese mathematics is a grateful subject for study as it confronts us with basic questions on the development of mathematics. The relative isolation of Japanese intellectual culture during the Edo period provides us with almost experimental conditions for the question if mathematics evolves in some necessary order or pattern. The confrontation with Dutch mathematics at the end of this period raises the issue how foreign knowledge can and should be incorporated within existing traditions. Of the possible strategies of adaption, integration or replacement the Meiji regime chose drastically for the latter one, abandoning its own rich and flourishing *wasan* tradition. The possible choices are exemplified by the first two Japanese works on Western mathematics. The *Seisan Sokuchi* tried to adapt Western procedures to *wasan*. Yanagawa criticized such approach and intended his *Yōsan Yōhō* to be a faithful rendering of Dutch methods and procedures but also terms and symbolic notations. We have situated this revolution in Japanese mathematics within the context of foreign threat and the development of a Japanese naval force. The Dutch played a major role in placing education in Western mathematics as a condition for their support to this enterprise. We have pointed out several connecting lines between the Nagasaki naval training program and the newly established *bansho shirabe-sho* institute. The educational approach taken in the Dutch books used for the training program fitted very well the ambitions of the Meiji regime. The influence of Dutch learning in the latter years of the Edo period may have been greater than believed.

Acknowledgements

This paper is based on research conducted during a stay in 2008 at Kobe University, Japan. The author wishes to thank his host professor Nobuo Miura for the support and hospitality. The paper was concluded while the author was a visiting fellow of the Sydney Center for the Foundations of Science at Sydney University.

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[98] Pels Rijcken, the main instructor in mathematics and officer in charge of instruction of the first detachment, was trained at the Breda military academy.
[99] Beckers, D. *"Het despotisme der mathesis"*, p. 238.
[100] Jansen, Marius B. "New Materials", p. 595.

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