Simon Stevin of Bruges
(1548-1620)

CONTENTS

INTRODUCTION

1. I have taken pains to give an account of STEVIN's life and works which be as accurate and as complete as the scale of this memoir would permit, and I trust that historians of science will find it useful and that some of my brief statements will challenge

criticism. However, we need considerably more : STEVIN's personality is such a great one that a very full biography should be eventually devoted to it. Investigations in the Dutch and Belgian archives may clear up moot points. Some additional light may be expected from ISAAC BEECKMAN's diary, of which our learned colleague of Vlissingen, Mijnheer CORNELIS DE WAARD, has been preparing an edition for many years. And let us hope that when the *Hollandsche Maatschappij der Wetenschappen* has finally completed its magnificent edition of HUYGENS' works and correspondence, (1) begun almost half a century ago, it will undertake the building of a similar monument to the memory of STEVIN. This might be done with the cooperation of a Belgian society for STEVIN's fame belongs equally to both countries.

The present memoir is hardly more than an introduction to the study of this subject which, if we would try to follow all of its ramifications, would involve a survey of almost every aspect of scientific thought in a critical and fascinating age.

A complete bibliography of Stevinian publications would be exceedingly difficult and tedious, for his works were often issued in strange ways. There are plenty of bibliographical irregularities and niceties to enchant bibliomaniacs, and to disgust the historians who are more interested in ideas than in the accidents of printing and publication. I have tried to give enough information to identify and date exactly each work, and not much more.

My main purpose has been to state STEVIN's main achievements and I have tried to do so as clearly and concisely as I could.

2. The Flemish mathematician SIMON STEVIN was perhaps the most original man of science of the second half of the sixteenth century. I say " perhaps " only because of his contemporary GALILEO (1564-1642) who was at least as original. However the latter was sixteen years younger than STEVIN and outlived him twenty-two years; though some of his discoveries were made at about the same time as STEVIN's, they were published much later; the fundamental works upon which his fame is based appeared only in the seventeenth century; the two most important many years after STEVIN's death. Hence it is not quite proper to compare both men : they belong to two succeeding generations.

(1) See *Isis*, 21, 213-15.

Moreover, the great Fleming is distinctly a man of the second half of the sixteenth century, while his Italian peer represents admirably the first half of the seventeenth century.

If we leave GALILEO " hors concours," STEVIN was undoubtedly the most original man of the second half of the sixteenth century, but he has not yet received the full fame he deserves. This may seem strange, for his greatness is conspicuous and not only in a single domain but in many. On the other hand it may be argued that he has been neglected because of his very originality and that such neglect thus becomes a sort of confirmation of his genius. It can be shown that one of his fundamental ideas set forth by him in 1585—three centuries and a half ago—has not yet been grasped by a very large section of the civilized and intelligent people of our own time. And how could people truly admire one whom they do not understand, how could they consider great a man whose greatness they have not yet been educated to appreciate ?

I. — STEVIN'S LIFE

3. STEVIN's life has not yet been thoroughly investigated and there are many obscure points relative to it which further studies might possibly elucidate. The little we know may be summed up as follows. He was born in Bruges in 1548, and was active for a time in Antwerp as cashier and bookkeeper; later he was employed in the financial service of his native city. Sometime after 1571 he left Bruges because he had failed to obtain a franchise from taxes on beer. He traveled in Prussia, Poland, Sweden, and Norway and finally established himself in the northern part of the Netherlands which had then already shaken off Spanish domination. In 1581, we find him in Leiden; in 1582, his first book appeared in Antwerp; and on the 16th of February, 1583 he was matriculated as a student of the University of Leiden. Later he taught mathematics at that University and the prince MAURICE OF NASSAU (2) was one of his pupils. By 1590 he was living in Delft, where he had undertaken to establish a new model of windmills for which he had received a patent *(octrooi)*

(2) MAURICE, count of Nassau, later prince of Orange and stadhouder of the United Provinces (born 1567, died 1625; stadhouder 1585-1625).

from the States-General in 1586; in 1592, he was put in charge of the " waterstaat " (waterways) of Delft.

4. He had been in communication at least since 1585 with the Delft patrician JOHAN HUGO CORNETS DE GROOT (3), for in that year he dedicated the *Arithmétique* to him. This JOHAN HUGO DE GROOT was deeply interested in mathematics and physics, and is many times mentioned by STEVIN (e.g., in the *Weeghconst* and the *Waterwicht* of 1586). During the latter's residence in Delft they had more opportunities of discussing scientific subjects together. It was probably then that they made experiments on falling bodies, disproving the Aristotelian idea that heavier bodies fall faster than lighter ones. (4)

5. In January 1593, upon the recommendation of the stadhouder MAURICE OF NASSAU (fig. 2) he was appointed by the States-General " castrametator," i.e., quartermaster general of the Dutch armies, a position which he held until the time of his death.

However, toward the end of his life, as he complained of the ungratefulness of the States-General, MAURICE OF NASSAU appointed him a member of his council and superintendent of financial matters.

In 1600, he organized the mathematical teaching at the engineering school attached by MAURICE OF NASSAU to the Leiden University (5),—that teaching being given in the national language, as opposed to the University itself where it was presumably given in Latin.

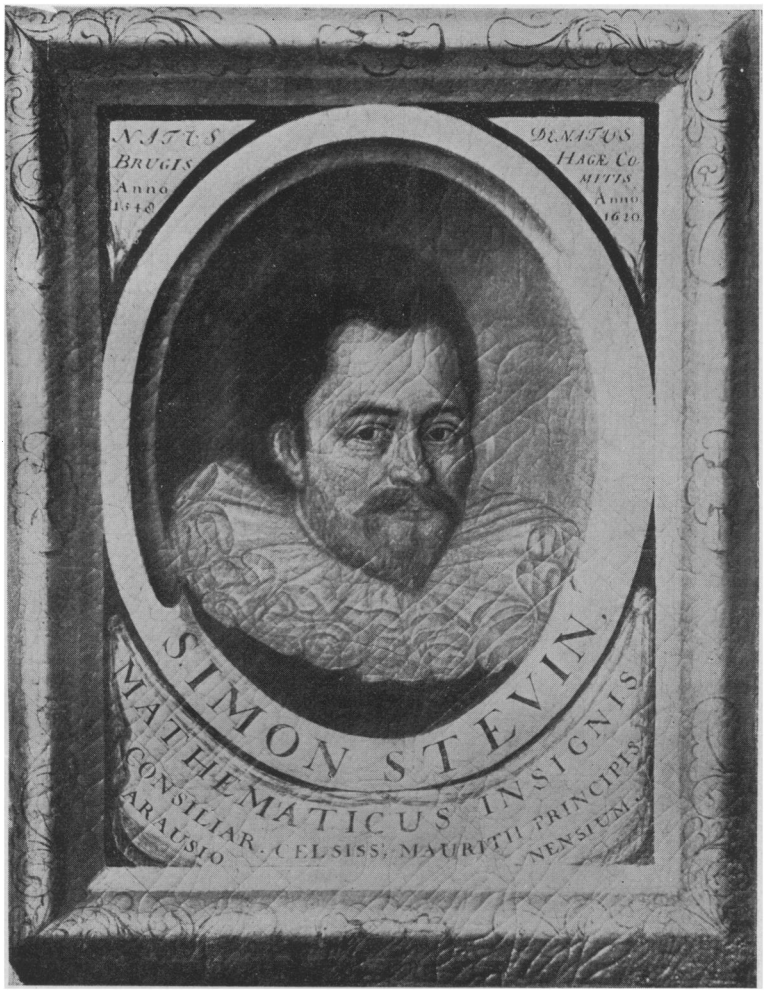
Prince MAURICE had a very genuine interest in mathematics (6) and his relationship with his tutor and technical adviser was

(3) Or JANUS GROTIUS. Born near Delft 1554; died in Delft 1640. Father of the more famous HUGO GROTIUS (1583-1645). Burgomaster of Delft 1591-95, curator of Leiden University 1594. See CORNELIS DE WAARD in *Nieuw nederlandsch biografisch woordenboek* (vol. 2, 528-9, 1912).

(4) This is said by W. VAN DER WOUDE and P. J. BLOK (N.N.b.w., 5, 816, 1921), I do not know on what grounds. They further claim that STEVIN and the burgomaster DE GROOT made those experiments before GALILEO. I am not able to confirm either the anteriority or even the reality of their experiments. GALILEO's experiments took place while he was living in Pisa, 1589-92. It is not possible I believe to date them more accurately. See VINCENZO VIVIANI's account in *Opere di* GALILEO (FAVARO's edition, vol. 19, 606, 1907).

(5) After W. VAN DER WOUDE and BLOK (op. cit., 816).

(6) CAPPELLE (1821).



Pl. i, fig. 1 SIMON STEVIN G. SARTON

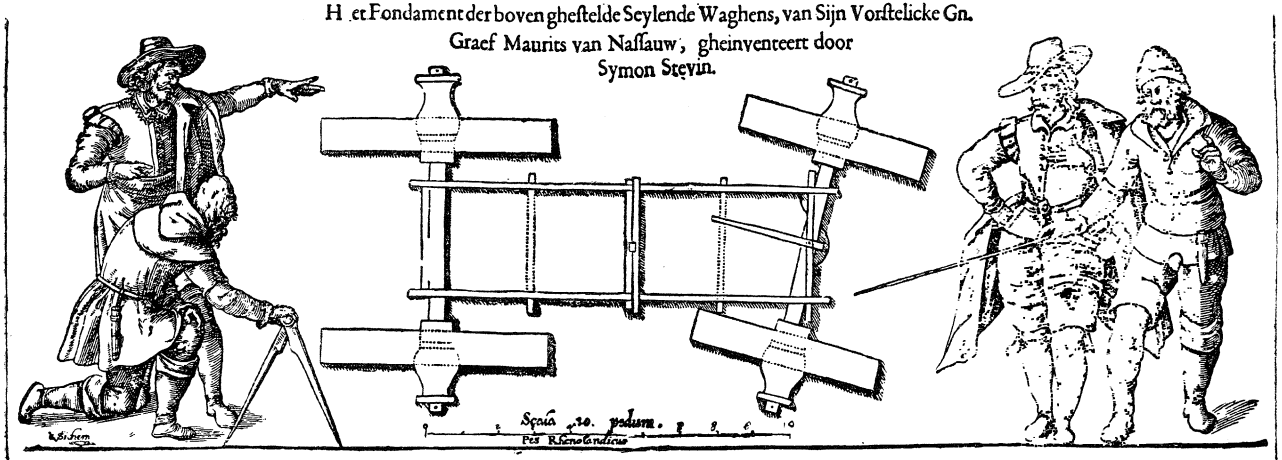
(By an unknown painter)

Pl. ii, fig. 2 MAURICE, prince of Orange G. SARTON

(Taken from the French *Castrametation.*)

Pl. iii, fig. 27 STEVIN's sailing chariots G. SARTON

(Engraving by JACQUES DE GHEYN (?), 1652)



Pl. iv, fig. 28 Chassis of STEVIN's sailing chariot G. SARTON

as intimate as it could be. A number of STEVIN's scientific writings were the fruits of that relationship. The Prince used to carry the manuscripts of them with him in his campaigns. Fearing that he might lose them, he finally decided to have them published, not only in the original Dutch text (*Wiscontighe ghedachtenissen*, 5 vols., 1605-8) but also in a Latin translation by WILLEBRORD SNEL (*Hypomnemata mathematica*, 5 vols., 1605-08) and in a French translation by JEAN TUNING (*Mémoires mathématiques*, only 3 1/2 vols. published 1605-8). It is true these memoirs might have been saved by the preparation of other manuscript copies, yet the printing of the Dutch text seemed advisable for three reasons clearly set forth in the preface which may be found in the three editions. As the French text is easier to read for most readers than either the Dutch or the Latin ones, I quote these three reasons from it :

" La premiere, que quelques uns, és mains desquels viendroient ces escrits, se pourroient attribuer nostre labeur & inventions; comme c'est chose qu'on voit bien arriver : A quoy le meilleur remede a semblé de les mettre en lumiere par le moyen de l'impression. La seconde, qu'il y auroit aussi cest avantage à attendre, que si quelques uns y rencontrent des fautes, ils les pourront corriger, et y joindre d'autres nouvelles inventions, profitables au public, & tendantes à plus grande satisfaction de celuy pour qui ces livres sont escrits. La troisiesme que, comme je declareray ci apres mon opinion estre que les grands arts & sciences ne peuvent parvenir à la perfection du siecle sage, si ce n'est que de grands peuples & nations s'y exercent en leur propre langue; puis que le present œuvre est formé avec esgard visant à telle fin, sans doute le recellement de ces livres n'accorderoit pas avec leur contenu, ni avec mon intention."

6. Late in life—he was then 64 years old—he married a young woman, named CATHARINA CRAEY. On March 28, 1612, he bought a house in The Hague; the house was not yet completely built when he acquired it but according to the contract it had to be delivered to him at the end of April. That house still exists in the Raamstraat no. 47 and is now marked with a bust of the great scientist. He obtained it presumably for the reception of the young wife whom he married in the same year. She gave him four children who were born in that house. FREDERIK, in 1613, HENDRIK, in 1614, and two daughters, SUSANNA and LEVINA. STEVIN died in 1620, presumably in The Hague and in that very house wherein we know that he spent the last years of his life. It is strange that the death of so great a man, a familiar

of the Prince, should have been almost unnoticed. However, the place, The Hague, is mentioned on the anonymous portrait which we reproduce (fig. 1), and if he had died away from his home, his death would have been probably more conspicuous.

CATHARINA did not remain a widow very long, for on February 28, 1621 she married MAURITS DE VIRY (or de VIRIEU), bailiff of Hazerswoude. They sold STEVIN's house on May 6, 1623 and established themselves in Leiden, where she died half a century later on January 5, 1673.

To return to the children. The eldest son FREDERIK was a student in Leiden and became a jurist; he died in Leiden in 1639, at the age of twenty-six. The second son HENDRIK, born a year after his senior in 1614, studied mathematical sciences in Leiden and became an engineer. He traveled in Bohemia, Italy, Belgium, Saxony— observing engineering matters everywhere. He was for a time quartermaster and engineer in the Dutch armies, until a wound obliged him to withdraw from such strenuous activities and to return to his studies. He established himself in Alphen (near Breda) where he was lord of a manor *(ambachtsheer)*. His interest in his father's work was much stimulated by the latter's eulogy in ADRIANUS ROMANUS' book : *Ideae mathematicae pars prima* (1593). He took considerable pains to collect his father's dispersed manuscripts and to publish them (see below 28-29). He shared his father's enthusiasm for the Dutch language and carried it to the point of fanaticism, for he was anxious not only to promote its study but also to exclude the teaching of Latin from the Dutch schools (a very bold proposal in his day). He claimed that every subject should be taught in the mother tongue and that foreign languages were of no use except to people who wanted to travel abroad and to study foreign cultures. He spent the end of his life in Alphen. He was in correspondence with CONSTANTIJN and CHRISTIAAN HUYGENS and with other mathematicians. He died after 1668.

7. In July 1846 a modest but beautiful monument was erected to STEVIN's memory in his native city, Bruges. This was the occasion of a long and heated controversy as to his loyalty to his fatherland and religion. (7) Looking at it from a distance

(7) An account of it will be found in the *Bibliotheca Belgica* (vol. 23, note on the *Vita politica*, S. 132, Ghent 1880-90, with bibliography).

that controversy seems particularly futile. When he was serving the Prince of Orange, STEVIN was helping him to fight not Belgium, but Spain. Did he become a Protestant? This is possible but unproved. In the *Vita politica* he recommends that one should practice one's own religion in secret if it be different from the Prince's, and not to disturb the public order. If he remained faithful to the Church of his baptism, he was a crypto-Catholic according to his own definition. If so, he would deserve some measure of blame, because Prince MAURICE was revolting not only against Spain but also against the Roman Catholic Church. Considering the general bent of his mind it is probable that he had little interest in theological differences. Moreover, had he not witnessed the intolerable excesses committed by Spain in his native land in the name of orthodoxy? In any case it is not true that he made a legacy to the church of Westkerke to pay for masses : (8) The man who made that legacy being a namesake who died in 1434.

II. — STEVIN'S WORKS

8. (S. 124). (9) *Tafelen van Interest, midtsgaders de constructie der seluer* (Tables of interest, together with their construction). 92 p. Antwerp, 1582. (In Dutch). For title-page see fig. 3.

Pp. 9-34 contain an account of the different kinds of interest and explain the composition of the tables; p. 35-59, tables of compound interest and notes relative to them; p. 60-92, applications. According to the author's own statement in his preface (dated Leiden, July 16, 1582), the inventor of these tables was JEAN TRENCHANT, who gave a specimen of them in his *Arithmétique* (Lyon, 1558). (10)

(8) A denial of this fact is necessary because it was adduced by no less an authority than MORITZ CANTOR in his articles on STEVIN in the *Allgemeine deutsche Biographie* (vol. 36, 158-60, 1893) and in the *Encyclopaedia Britannica* (11th. ed. 1910, 1 ½ col.). It is no longer found in the 14th ed., the Editor having decided that STEVIN did not deserve so much space and telescoped CANTOR's article to one third of its original length.

(9) This number and the corresponding ones below refer to the notices in vol. 23 of the *Bibliotheca Belgica* (Gand, 1880-90) where additional information may be obtained. I have tried to give all the information which is of real interest to the historian of science, as opposed to the bibliographer and the bibliophile.

(10) *L'Arithmétique de* IAN TRENCHANT *départie en trois livres. Ensemble un*

A French translation of STEVIN's tables was published in his *Pratique d'arithmétique* (Leiden 1585, 1625) mentioned below, and reprinted in GIRARD's edition (1634), though without the preface.

Judging from GIRARD's publication (for I have not seen the original Dutch book), there are sixteen tables of interest from 1 % to 16 %, each for n years (n = 1 to 30). Each table is divided into three columns, of which the first gives the number n, the second the capital which will be worth, together with the compound interest, 10.000.000 after n years, the third the value of n annuities of 10.000.000 at the beginning of the first year (of course the numbers of the third column are simply the totals of the numbers of the second column down to that year).

These tables are followed by seven others entitled " Table d'interest du denier n " (n = 15 to 19, 21, 22). The " table du denier 20 " is not given as it is identical with the table of interest for 5 %.

STEVIN's tables were the first to appear in print but of course manuscript tables of the same kind had been used by bankers long before his day. The earliest we know of were compiled c. 1340 by FRANCESCO BALDUCCI PEGOLOTTI for the great commercial firm BARDI of Florence, and included in his treatise *Libro di divisamenti di paesi e di misure di mercatanzie* (or *Pratica della mercatura*) and edited by GIAN FRANCESCO PAGNINI : *Della decima e di varie gravezze imposte dal comune di Firenze* (4 vols., Lisbona and Lucca, 1765-6; in vol. 3). The use of such tables was transmitted from Italy to other countries, chiefly those like the Netherlands where the commercial activity was greatest, but their diffusion was probably slowed up by the fact that bankers having them would be likely to consider them as secret tools of their trade, and at any rate would have no interest in communicating them to their rivals.

9. (S. 125). *Problematum geometricorum libri V* (118 p.) Antwerp (s. a., 1583). For title-page, see fig. 4.

Collection of geometrical problems arranged in the following order : Book I. Division of polygons *(a)* by a line passing

petit discours des Changes, avec l'art de calculer aux getons. This work was very popular being printed at least 16 times within a century. The author is otherwise unknown. See my query no. 38 in *Isis*, 21, 207-9, 1934.

through a point of the perimeter or *(b)* by a parallel to one of the sides. Book II. Application of the *regula falsi* to mensurations. Book III. Regular polyhedra and semi-regular polyhedra which can be inscribed in a sphere (quinque corpora regularia, quinque aucta corpora regularia, novem truncata corpora regularia). Book IV. Construction of a solid similar to another, and equal in volume to a third. Book V. Construction of a solid similar to two others and equal in volume to their sum or difference. STEVIN's references to EUCLID are to the CLAVIUS edition of Cologne 1574. An elaborate analysis of this work was published by GRAVELAAR in 1901.

10. (S 126 and 127). *Dialectike ofte bewysconst. Leerende van allen saecken recht ende constelick oirdeelen; oock openende den wech tot de alderdiepste verborghentheden der natueren* (12 l., 172 p.) Leiden 1585 (in Dutch). For title-page, see fig. 5.

This is a treatise on " dialectics and the art of demonstration " which the author composed in the form of a dialogue between PIETER and JAN (PIERRE et IEHAN). STEVIN was deeply convinced of the actual or potential superiority of the Dutch language over all others, yet he realized the temporary insufficiency of the Dutch scientific terminology, and tried to remedy it. The *Bewysconst* includes (p. 134-40) a Latin-Dutch glossary of logical terms.

The need of technical books in Dutch at that time is illustrated by the contemporary publication of two other ones. NICOLAS PETRI of Deventer : *Practique om te leeren rekenen, cijpheren ende boeckhouwen.* Amsterdam 1583. (Arithmetic including book-keeping) and the anonymous *Ruygh-bewerp vande redenkaveling ofte nederduytsche dialectike.* Leiden 1585 (on dialectics). Such books were in demand because there was a group of people constantly increasing in numbers and importance—merchants, bankers, etc.—who did not know Latin yet were keen to obtain useful knowledge.

STEVIN's book was published a second time in Rotterdam 1621. This edition does not seem to differ at all from the first, except with regard to the orthography.

STEVIN refers to the *Bewysconst* in his *Thiende* (see our facsimile p. 157).

11. (S 128). *De Thiende.* 36 p. Leyden 1585.

The tithe. I shall discuss this book more fully in another paper.

12. (S 129, 130). *L'Arithmétique et la Pratique d'Arithmétique* (2 vols., 9 l. + 642 p. + 7 l., 203 + 12 p.). Leiden 1585.

See facsimiles of the two titlepages (the first title is very long) in my second paper.

Vol. 1 contains the arithmetic in two books; then a French translation of the first four books of the algebra of DIOPHANTOS (free version from XYLANDER's Latin text, 1575). This was the first translation of DIOPHANTOS in any European vernacular.

Vol. 2 *(Pratique)* contains rational computations, then proportional computations. Then : rule of three, rule of five, rule of company (i.e., compound proportion), rule of alligation, rule of interest and tables of interest (translation of item in § 8), rule of false position, the tithe (translation of item in § 10), surds and explanation of book X of EUCLID's Elements. (11)

At the end of the *Pratique*, the author mentions two friends of his, JOHAN CORNETS DE GROOT (father of HUGO GROTIUS) who is helping him for his statics, and LUDOLF VAN CEULEN, with whom he is constantly discussing mathematical subjects.

This work though very original is based to a large extent upon the writings of CARDANO, TARTAGLIA, BOMBELLI, and to a lesser extent upon those of RUDOLF, STIFEL, and PEDRO NUÑEZ.

A revised edition of the *Arithmétique* was prepared by ALBERT GIRARD (Leiden 1625). GIRARD added to it a translation from the Greek of books 5 and 6 of DIOPHANTOS and STEVIN's Appendice quoted below (§ 15); he made also a few other changes of no importance. GIRARD's edition was reprinted without ulterior modification in the *Œuvres* of 1634 (vol. 1).

13. (S 131). (a) *De Beghinselen der Weeghconst* (18 l., 95 p.) Leiden 1586.

Treatise on statics divided into two parts dealing respectively with principles and the determination of centers of gravity.

(b) *De Weeghdaet* (43 p.) Leiden 1586.

Praxis artis ponderariae. Statical applications.

(c) *De Beghinselen des Waterwichts* (81 p.) Leiden 1586. Principles of hydrostatics. For the three title-pages, see figs. 6-8.

(11) A propos of this last part see M. MERSENNE : *Traité des quantités incommensurables... Les erreurs de S.S. réfutées* (anonymously published in Paris 1640).

These three booklets are quoted together as they were published together by the same publisher with the same woodcut and motto "*Wonder en is gheen wonder.*" Though independent they may be considered three parts of the same book, sold separately for commercial or other reasons.

The three pamphlets were reprinted by STEVIN under the single title *Weeghconst* in his *Wisconstighe ghedachtenissen* (vol. 4, 1605). He was planning to write two others, including one on aerostatics, but failed to do so.

In the first and third STEVIN reiterates his conviction of the excellence of the Germanic languages. According to him Dutch is the best language for scientific purposes because it combines briefness with clearness. He maintains that in that respect Dutch is superior to Greek and Latin, and in proof of his assertion quotes the Latin translation by FEDERICO COMMANDINO of two propositions of APOLLONIOS of Perga covering no less than 36 lines and adds a Dutch translation covering only 9 lines. He announces his intention of translating APOLLONIOS into Dutch, a purpose which he could not fulfill.

According to him the superiority of Germanic languages, and particularly of the Dutch, was due not only to their brevity and richness in monosyllables, but also to their lending themselves so well to the creation of intelligible compound words (12), to their convenience for technical purposes, and finally to their moving power. As an illustration of the latter he mentioned the existence of so many religious sects in the Germanic lands! STEVIN was arguing in a strangely egocentrical way, and did not realize that the power of the Dutch language to move him was essentially due to the fact that it was his mother tongue, his very own. He came back to this question in his Geography, and also in the Preface to his *Hypomnemata* (13). He was a poor philologist—and not in any sense a humanist but rather the opposite—yet he discovered the fundamental argument for the justification of any language however unimportant that language may seem as compared with other ones: that the full spiritual development of a people can only be accomplished by means

(12) E.g. hoekmaet for sine; aardrijkskunde for geography; wiskunde for geometry.

(13) See *Praefatio* and *De renovatione eruditi seculi* (2 membrum, etc.).

of its own language (see end of the French preface quoted above in § 5).

It may be added that STEVIN's claims for the Dutch language were also justified in his day by the political and economic leadership of the Dutch people—that is, not STEVIN's own countrymen but those who had freed themselves from Spain and Rome : this was the true Golden Age of the Seven United Provinces.

14. (S 132, 133, 134). *Vita politica. Het burgherlick leuen* (56 p.) Leiden 1590 (in Dutch). For title-page, see fig. 9.

Treatise on civics which the author composed 1° because he considered it more necessary than ever in those troubled times that every citizen should know his duty, 2° because it gave him a new opportunity of using the Dutch language and enriching it. He had to solve problems of terminology similar to those of his Dialectike. In some cases he puts in the margin the Greek and Latin equivalents of the Dutch terms used by him.

The *Vita politica* is divided into eight chapters : 1. Definition of civic life; 2. What is the foremost authority of the state; 3. How to determine the political party which one should join; 4. Civic duties of people in authority; 5. How should the citizen behave with regard to the laws which are not considered obligatory, but rather doubtful or contradictory; 6. Whether religion is necessary or not; 7. Rules of conduct in religious matters; 8. Civic life in general.

This table of contents, naked as it is, helps us to realize how difficult it was to be a good citizen in those days, for many issues were uncertain, and there were many conflicting duties. The main difficulties—the religious ones—are discussed in the two final chapters. It is in those chapters that STEVIN recommended that people who did not share the Prince's religion should conform outwardly and avoid any disturbance of the public peace (see our § 7). It is very easy to criticize that theory to-day, but it was probably the wisest in STEVIN's time and place.

The *Vita politica* was reprinted many times : Delft 1611, Middelburg 1658, (with a long appendix), Amsterdam 1684 (without the appendix; reimpression of the first two editions); again in the *Materiae politicae* edited by STEVIN's son (with the appendix).

15. (S 135). *Appendice algébraique contenant règle générale de toutes Equations* (3 l.) Leiden 1594.

Supplement to the *Arithmétique*.

This is one of STEVIN's most important publications : it includes a general rule to solve numerical equations of every degree. Expressed in modern language : if $f(a) > 0$ and $f(b) < 0$, there is between a and b at least one root of the equation $f(x) = 0$. At the end of this short paper STEVIN announced that his friend LUDOLPH VAN CEULEN had also found a general rule for the same purpose and that he had promised to publish it. LUDOLPH VAN CEULEN has not kept his promise but judging from his treatise *Van de circkel* (Delft 1596) he could solve numerical equations of any degree. Another friend of STEVIN's, ADRIAN ROMANUS, could also solve them (see his *Idea mathematica*, Antwerp 1593). STEVIN was the only one who published his method, and he thus deserves full credit for it.

The unique copy of the *Appendice*, kept in the University Library of Louvain was lost when that library was destroyed by the Germans in 1914. However, the text has been preserved for it was reprinted in the second edition of the *Arithmétique*, in the Dutch, Latin, and French editions of the *Hypomnemata mathematica* (see *Hypomnemata* ,vol. 5, p. 7-9, *Datis tribus* etc.); and in GIRARD's *Œuvres* (Arithmétique, p. 88).

16 (S. 136, 137). *De Sterctenbovwing* (4 l., 91 p.) Leiden 1594 (in Dutch). For title-page, see fig. 10.

Treatise on fortification which the author composed in Dutch because he was anxious to serve his countrymen, and also because (so he said), the Dutch language was especially adequate for technical purposes. His opinion on the subject is fortified by some remarks of CARDAN (*De subtilitate*, book 2). This treatise was much praised by the famous Belgian military engineer, HENRI ALEXIS BRIALMONT (1821-1903) in an appendix to STEICHEN's *Mémoire* (1846).

Reprinted, Amsterdam 1624. German translation, *Festung-Bawung*, by GOTTHARD ARTHUS (1570-after 1630) of Danzig (Francfort a.M., 1608, again 1623). French translation by GIRARD in the *Œuvres mathématiques*.

17. (S. 138, 139). *De Havenvinding* (28 p.) Leiden 1599. For title-page, see fig. 11.

The States-General gave the printer, CHRISTOFFEL VAN RAPHELENGEN, by privilege dated March 18, 1599 the exclusive right for six years to print and sell this book in any language. The printer himself expressed his intention of publishing it in Latin, French, Dutch and other languages.

Treatise explaining to sailors how to determine their landings by means of the compass. According to the preface, MAURICE OF NASSAU had ordered all the sea captains to make observations of magnetic deviation and to report them to the admiralty.

The treatise includes a table *(Tafel der naeldwijsinghen)* giving the deviation, latitude, and longitude of some 43 places. The longitudes are very erroneous, the average error amounting to 6° 5. (14) The table is arranged in a curious manner. The places quoted are divided into four regions : first " percx " on the northside, second " percx " on the northside, first " percx " on the south side, second " percx " on the south side (excepting Goa, Cochin and Canton). In the first, the deviation is easterly, it increases from 0 to 13.24 then decreases to 9.30; in the second, it is westerly and increases from 0 to 33 then decreases to 26; in the third, it is easterly and increases from 0 to 19 then decreases to 2.30; in the fourth it is westerly and increases from 0 to 22 (15) then decreases to 0. According to STEVIN himself (Definition 1) the data were collected by PETRUS PLANCIUS (16) and credit for this invention *(havenvinding)* should thus be given to the latter. After perusing this little book I cannot help feeling that STEVIN had at first greater hopes in the practical value of deviation than later experiments known to him justified; he then restricted the scope of his method : the determination of deviation could not replace that of longitude in general navigation; yet it would be useful to identify one's landings. Even that modest hope had to be abandoned later on.

STEVIN's moderation will be better appreciated by reference to the contemporary theories attempting to establish a regular

(14) MARGUET, 1931, 60.

(15) With one irregularity : 13, 16, 15, 22.

(16) PIETER PLATEVOET, Dutch preacher and geographer (1552-1622). See elaborate biography by A. A. VAN SCHELVEN in *Nieuw Nederlandsch biografisch woordenboek* (4, 1077-86, 1918), wherein the *Havenvinding* is wrongly ascribed to PLANCIUS. This PLANCIUS is said to have drawn a map on MERCATOR's (or rather WRIGHT's) projection in 1594, but that map is lost (MOTTELAY 1922, 560).

connection between variation and longitude : thus GIAMBATTISTA DELLA PORTA in his *Magia naturalis* (see edition of Naples 1589, p. 143) and others leading to the extravagant treatises of the Languedocian GUILLAUME LE NAUTONIER : *Mécographie de l'eymant. C'est à dire la description des longitudes trouvées par les observations des déclinaisons de l'eymant* (Venes 1603) and *Mécométrie de l'eymant. C'est à dire la manière de mesurer les longitudes par le moyen de l'eymant* (Paris 1602, Venes 1603) (or both books together dated 1604). (17) That intrepid theorician did not hesitate to draw a magnetic chart of the world *a priori !*

STEVIN published *De havenvinding* anonymously but included a revised edition of it in his *Wisconstige gedachtenissen* (1, 163-75). A part of the original text is included in the *Rara Magnetica* edited by GUSTAV HELLMANN in his *Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus* (no. 10, Berlin 1897). HELLMANN's reprints contain a facsimile of the Dutch title-page, the " *Tafel der naeldwijsinghen* " and " *Hoemen het noortpunt en naeldwijsing vindt*", 2 figs. (the text is not a facsimile reproduction).

A Latin translation by no less a person then HUGO GROTIUS was published by the same publisher in the same year :

Λιμενευρετικη sive, Portuum investigandorum ratio. Metaphraste HUG. GROTIO Batavo (6 l., 21 p., 1 p.) Leiden 1599.

This text was reprinted in the *Hypomnemata* after revisions bringing it into agreement with the revised Dutch text published in the *Wisconstige gedachtenissen.*

An English version was made by EDWARD WRIGHT (1558?-1615) on August 23, 1599. :

The Haven-finding art (cover, 7 l., 27 p.) London 1599. There is a copy of this book in the Library of Congress and I examined another one in the Huntington Library in San Marino, California (see fig. 12). This translation was reprinted in the third (posthumous) edition of WRIGHT's *Certain errors in navigation detected and corrected* (London 1657, 20 p. at end), but not in the first and second editions of that book (1599, 1610).

The *Haven-finding art* of 1599 begins with an *Epistle dedicatorie*

(17) MARGUET (1931, 98). This question—variation vs. longitude—is very interesting but equally intricate. See MOTTELAY (1922, 63). Mme. PAUL TANNERY : *Correspondance du* P. MARIN MERSENNE (vol. 1, 202, 207, 1933).

to the Lord High Admiral of England, which includes a reference to the discovery of the inclination by ROBERT NORMAN (1576, published in his *Newe attractive*, 1581).

A French edition had been planned from the beginning, but was not published separately. It is included under the title *Du Trouve-port, ou la maniere de trouver les Havres*, in GIRARD's *Œuvres* (vol. 2, 171-76, 1634).

18. (S. 140, 141, 142, 144). *Wisconstige Gedachtenissen, inhoudende t'ghene daer hem in gheoeffent heeft...* MAURITS *Prince van Oraengien* (2 vols. folio, very complicated pagination) Leiden 1605-1608 (in Dutch). For title-pages, see figs. 13-14.

This contains the substance of the lessons which STEVIN gave Prince MAURICE on a great variety of mathematical subjects; it is a sort of mathematical encyclopaedia. The Prince used to carry manuscript copies of these lessons with him in his campaigns and on one occasion he almost lost them. He then decided to have them published not only in the original language, Dutch, but also in Latin and French translation. This was done except that the French translation, or at any rate its publication, remained incomplete.

The titles of the Latin and French editions are :

Hypomnemata mathematica, hoc est eruditus ille pulvis, in quo se exercuit... MAURITIUS *princeps auraicus... A* SIMONE STEVINO *conscripta, & e Belgico in Latinum* a VVIL. SN. *conversa* (5 vols. folio, very complicated pagination). (18) Leiden 1605-8. For title-pages, see fig. 15-16.

Mémoires mathématiques, contenant ce en quoy s'est exercé MAURICE *Prince d'Orange... Descrit premierement en Bas Alleman... translaté en François par* IEAN TUNING (4 parts in one vol.) (19) Leiden 1605-8. For title-page, see fig. 17.

The French translator, JEAN TUNING was secretary to Prince FREDERIK HENDRIK OF NASSAU (1584-1647), MAURICE's young brother; he was born in Leiden and matriculated at the University of Leiden in 1593.

---

(18) The copy I used in the Harvard Library is bound in one thick volume (30 × 20 × 10 cm.).

(19) The copy available to me in the Harvard Library is incomplete. It contains only vol. 1, 1608, Cosmographie, 180 p. (incomplete); and Vol. 2, 1605 Practique de géometrie, 132 p.

It is remarkable that on the Latin title page STEVIN's language is caled " Belgian " (20)—a term new to me in that acceptation—and on the French title page, " Low-German." The second designation is not incorrect, and tallies with the official name " Netherlandish." The first is stranger. Of course STEVIN's mother tongue was Flemish, but it is possible that it had been somewhat Dutchified during his long residence in Holland : this question might interest philologists but I cannot stop to consider it. It will suffice to remark that Flemish is a dialectical form, or rather a collection of dialects, closely related to the Dutch dialects. Flemings and Dutchmen use the same grammars and dictionaries; the Flemish and Dutch languages are not more different than the American and the English languages. In other words, —for almost every purpose we may consider them as a single language. One wonders then what was the intention of the Dutchman who called STEVIN's language " Belgian "; or maybe he had none.

The Latin translation was made by WILLEBRORD SNEL VAN ROYEN (21), Dutch mathematician, geodesist and physicist. According to HUYGENS it was SNEL who first discovered and discussed in his lectures at the University of Leiden the fundamental law of refraction later published (without experimental proof) by DESCARTES (1637). SNEL translated the whole of STEVIN's *Wisconstige gedachtenissen*, except that the text of the *Liber quintus geographiae De limenheuretica* is simply a revision of HUGO GROTIUS's version.

For scientific purposes the Dutch and Latin texts are equivalent. As the Dutch text is not available to me, and the Latin text is easier to consult by the majority of readers, I shall take the latter as the basis of my analysis. It must be understood that each treatise exists not only in Dutch, but also in French, unless I state the contrary.

19. With regard to the date it should be noted that the publica-

(20) ADRIAAN VAN ROOMEN, speaking of STEVIN's language in his *Idea mathematica* (1593), also calls it " lingua belgica." HENDRIK STEVIN, SIMON's son, translating this very passage into Dutch, calls it " nederduytsche taal." "Lingua belgica" is Latin purism, just as " lingua sarmatica " to mean Russian.

(21) WILLEBRORD SNELLIUS (1580-1626). The original Dutch name is SNEL, not SNELL. See elaborate biographical notice by CORNELIS DE WAARD : *Nieuw nederlandsch biografisch woordenboek*, 7, 1155-63, 1927.

tion of the three editions—Dutch, Latin and French—was begun in 1605 and completed in 1608. In each case the title of the first volume bears the date 1608 (see figs. 13, 15, 17), which simply means that that title-page was printed last. I have examined more closely the Latin edition, the only one which was completely available to me (I used also a part of the French one), and in that edition the main title-pages of vols. 1 and 5 bear the date 1608, and those of vols. 2 to 4, the date 1605, but vol. 1 is divided into three parts of which the first and third are not dated, but the second is dated 1605. Hence vols. 1 to 4 of the Latin edition were probably printed in 1605, except two parts (Parts 1 and 3 of vol. 1), which may have been printed at any time between 1605 and 1608; while volume 5—which is in the nature of a general supplement—was probably issued in 1608. After the work had been kept on the stocks almost four years the printer became impatient and the publication was completed somewhat abruptly. This is explained at the end of it (see vol. 5, 205 of Latin edition, also end of my § 24).

20. The *Hypomnemata* are divided into five volumes which we shall now examine in due order.

Vol. 1. Cosmography (*Tomus primus de Cosmographia*, 1608). This is subdivided into three parts (each with its own pagination !) : *(a)* Trigonometry in four books (343 p.); *(b)* geography in six books (188 p.); *(c)* astronomy in three books (335 p.); that is, in all 866 p. not counting many unnumbered leaves.

(a) Trigonometry *(Pars prima cosmographiae de triangulorum doctrina)*. No date on separate subtitle page. Book 1. De sinuum canonibus fabricandis. Construction of tables of sines, tangents and secants, together with such tables. The tables were not reprinted in GIRARD's *Œuvres*, GIRARD having published independent tables (The Hague 1626) which were far more convenient. Book II. De triangulis planis (plane trigonometry). Book III. De sphaericis triangulis (spherical trigonometry). Additamentum. De sphaericis multangulis. Appendix doctrinae triangulorum. Book IV. De cœlestium sphaerarum problematis, quae ex calculo sphaericorum triangulorum solvuntur (trigonometrical applications to astronomical problems).

STEVIN's trigonometry was partly translated and published in German (S. 144) :

SIMONIS STEVINI *Kurtzer doch grundlicher Bericht von Calculation der Tabularum Sinuum, Tangentium und Secantium...* (Nuremberg 1628).

This translation was made by, or under the auspices of, DANIEL SCHWENTER (1585-1636), professor of oriental languages and mathematics in Altdorf, who wrote an introduction to it. It covers only the first book of STEVIN's trigonometry, less the tables, and the beginning of book II. Apparently SCHWENTER (or the translator) did not have access to a complete copy, for he quotes in his preface four axioms of BARTHOLOMAEUS PITISCUS concerning spherical angles, because (so he says) STEVIN has entirely neglected that subject. It would thus seem that SCHWENTER knew only of the first two books, and this would suggest that the publication of STEVIN's works was even more fragmentary than we realize otherwise. The second part of SCHWENTER's edition contains tables of sines, tangents, and secants, calculated with reference to a radius divided into 10.000.000 parts, by JOHANNES PRAETORIUS.

(b) Geography, 1605 *(Secunda pars cosmographiae de geographia)*. Not translated into French except book V, but there is a complete French translation in GIRARD's *Œuvres* (vol. 2, 104-83, 1634). Book I. De geographiae definitionibus generatim (p. 1-45, general definitions).

This includes some extraordinary developments on the "*eruditum seculum*," a mythical age of learning and wisdom.(22) STEVIN's belief in the existence of that golden age is justified by arguments largely drawn from the history of ancient science (p. 8-14), and is bolstered up by a series of testimonies culled out of the ancient literatures by HUGO GROTIUS. (23) Finally he draws up a program of efforts which may lead to the restoration of that time of wisdom, and manages to introduce into this a new vindication of his own

(22) " Eruditum seculum dicimus, quo mirabilis quaedam scientia hominibus nota fuit, quod certis quibusdam signis certo quidem, sed nec apud quos, aut ubi locorum, aut quando extiterit cognoscimus " (p. 8). See also end of the preface to the *Mémoires* quoted above (§ 5).

(23) Testimonia aliquot perantiqui et sapientis cujusdam aevi a HUGONE GROTIO collecta (p. 15-16). A French version of STEVIN's lucubrations on the age of wisdom may be read in GIRARD's *Œuvres* (2, 106-25) together with GIRARD's strange commentary. GIRARD's attack of the French language in a French book is certainly curious.

beloved language—together with tables of Dutch, Latin and Greek monosyllables, to illustrate what he considered to be one of the chief merits of the Dutch language, its great richness in monosyllables and its concision. (24)

The idea of a primordial golden age is one of the oldest conceits of the human mind. Our Edenic belief or dream is but one of its forms, and that particular form can be traced back to Sumerian times. (25) The fact that such strange ideas may be found alongside others of the purest scientific kind is but another illustration of the infinite complexities of the human mind. No man is always consistent, certainly no man of genius; or to put it otherwise, when consistency exists it is more often than not combined with mediocrity.

Book II. De hylocinesi terrestris globi (p. 47-67; on material changes of the earth). Much of this would be classified today under the heading of geology. Book III. De terrestri atmaeoria (26) (p. 69-81; on the height of clouds). Dealing with the height of the atmosphere with reference to IBN AL-HAITHAM as translated by GERARD OF CREMONA and to PEDRO NUÑEZ (1492-1577). Book IV. De histiodromia (27) (p. 83-159; on the road followed by a sailing boat). Problem of the loxodromic line and tables ad hoc, Canones loxodromicorum. Book V. De limenheuretica (28), metaphraste HUG. GROTIO (p. 161-173). See our § 17, Book VI. De theoria maritimorum aestuum in accessu et recessu (p. 175-83; on tides).

(c) Astronomy *(Cosmographiae pars tertia de cœli motu)*. No date on separate subtitle page. Not available in French, except later in GIRARD's *Œuvres*. Book I. De investigatione motus planetarum syderumque coelo affixorum ex observationum Ephemeridibus stante et quiescente terra (p. 1-114; Study of stellar and planetary motions on the hypothesis of the fixity of the earth). Book II. De investigatione motus planetarum ex ratiocinio mathe-

(24) Another example of a similar incongruity (irrelevant defense of the Dutch language in a scientific argument) may be read in the *Thiende*. See our facsimile of the French translation (p. 157).

(25) G. CONTENAU : Manuel d'archéologie orientale (Paris 1927, 315; *Isis*, 20, 474-78).

(26) Vaporium altitudine.

(27) De velificationis cursu quam dixeramus Nausiporiam.

(28) Portuum investigandorum ratione.

matico ad commentitiam stantis terrae hypothesin derivata (p. 115-231). Mathematical calculations on the same basis. Book III. De investigatione motus planetarum ex ratiocinio mathematico ad veram et naturae rerum consentaneam motae Terrae hypothesin derivata (p. 233-335). Same study on the correct Copernican hypothesis. Additamentum motus latitudinis quinque planetarum, Saturni, Iovis, Martis, Veneris & Mercurii secundum stantis Terrae hypothesin (p. 297-309). Appendix de ignorato planetarum motu ab Ptolemeo notato & animadverso : deque COPERNICI theoricis inde constitutis (p. 310-35). This ends the Tomus primus, which is somewhat larger than the four other tomi put together.

21. Vol. 2. Geometry (*Tomus secundus de geometriae praxi*, 184 p., 1605). In six books of which only books I to IV are translated into French (The French translation of books V and VI was added later by GIRARD in the *Œuvres*). This work is different from the *Problemata geometrica* and inferior to it; it is also a collection of geometrical problems but it is not arranged as logically as the former; it was chiefly made to complete the Prince's geometrical training. (29) Book I. De magnitudinum descriptione. (p. 5-44). Book II. De magnitudinum dimensione (p. 45-89). Book III. In magnitudinum additione, subductione, multiplicatione et divisione (p. 91-109). Book IV. In magnitudinum proportione (p. 111-22). Book V. De sectione proportionali (p. 123-53). Book VI. De magnitudinum in alias 'ομογένεας transformatione (p. 155-184).

22. Vol. 3. Optics (*Tomus tertius de optica*, 100 p., 1605). The Dutch original text is entitled *Van de deursichtighe* (perspective); this illustrates an equivocation which can be traced back to mediaeval times (30). STEVIN planned to write three books which are announced at the beginning of this volume (31), yet only two appear in the Dutch and Latin editions. As to the French edition, it includes only the first book, and this book was not even translated until the end (There is a French version

(29) Argumentum (p. 3) : Cum mecum geometriae πράξιν scribere constituissem, ut in ea Illustrissimum meum Principem exercerem...

(30) SARTON : *Introduction* (vol. 2, 23).

(31) Optica tribus libris comprehendimus : primo sciagraphiam, secundo radiorum reflexionem, tertio refractionem expositurі.

of book II in GIRARD's *Œuvres*). It would seem that the work was suddenly interrupted during the printing of it; according to TUNING's testimony, the printer was anxious to be through with it and became very impatient.

Book I. De sciagraphia (p. 3-85). This is what VITRUVIUS or HERO called scenographia, and corresponds more closely to modern perspective. According to STEVIN's first definition " Sciagraphia est rerum exstantium plana imitatio quae tamen eminens quoque videatur." Book II. De primis elementis catoptricae (p. 87-100). Theory of mirrors. Appendix : Discussion of virtual images on the basis of propositions of EUCLID, IBN AL-HAITHAM and WITELO. The absence of book III, which was to deal with refraction is very remarkable and the more so because the translator WILLEBRORD SNEL was destined to immortalize his name a few years later by his successful investigation of that very subject.

23. Vol. 4. Statics (*Tomus quartus de statica*, 196 p., 1605). For title-page, see fig. 16. Not available in French (except in GIRARD's *Œuvres*). STEVIN's three books on statics and hydrostatics are here reprinted but divided into five books, and supplementary materials form the substance of a sixth part. Book I. De staticae elementis (p. 3-51). Book II. De inveniendo gravitatis centro (p. 53-77). Book III. De staticae praxi (p. 79-108). Book IV. De hydrostatices elementis (p. 109-141). Book V. De initiis praxis hydrostatices (p. 143-49). Appendix statices, ubi inter alia errores quidem *Στατικῶν ἰδιωμάτων* refelluntur. Refutation of Aristotelian mechanics (p. 150-5). (Part VI). Additamentum staticae (p. 157-196). The summary announces that this supplement contains six parts, but only four were published. *(a)* De spartostatica (funium statica, statics of strings or ropes). *(b)* De trochleostatica (study of pulleys). *(c)* De fluitantibus acrobaricis (equilibrium of floating bodies, such as ships, of which the emerging part is high and heavy). *(d)* De chalinothlipsi (i.e., fremorum pressu), on the pressure of bits ! The two other parts which were announced but not completed in due time and not included are *(e)*. De hydatholcia (aquae attractu). *(f)* De aërostatica (aerostatics) (32).

(32) The learned editors of MERSENNE's correspondence (Mme. P. TANNERY and CORNELIS DE WAARD) make a puzzling reference (vol. 1, 596, 1933) to " un traité spécial que STEVIN composa avant 1585 sur la pesanteur de l'air. " No

24. Vol. 5. Varia (*Tomus quintus de miscellaneis*, 1608). In the preliminary announcement six parts are announced, but only the first two were actually published. Part I. De annotationibus arithmeticis (6 p.) *(a)* Discussion of a problem of DIOPHANTOS " 19 Zetema 2 libri " (33). *(b)* Latin version of the *Appendice algebraique*, for which see section 15 above. Part II. De apologistica principum ratione italica (204 p.). This is a translation of the Livre de compte de prince (section 25). The four unpublished sections would have been entitled : III. De musica theoria, IV. De architectura, V. De polemica, VI. De variis. A part of them was published by HENDRIK STEVIN.

P. 205 of vol. 5 contains a list of all the parts which had to be omitted though their publication had been announced, eight in all, i.e., the four just mentioned, one in optics, two in statics, and more arithmetical notes than the two named above (part 1 of vol. 5),—and gives an explanation of their absence : the printer's impatience; he was tired of keeping indefinitely the sheets already printed and suggested that additional materials could be published independently later when the author had completed their redaction. Table of contents of the five volumes (p. 206-10). Errata (p. 211-14).

25. (S. 143). *Livre de compte de prince à la manière d'Italie, en domaine et finance extraordinaire, estant aux Mémoires mathématiques la deuxiesme partie des meslanges, contenant ce en quoy s'est exercé... le prince d'Orange* (in all 204 p.) Leiden 1608. For title-page, see fig. 18.

Reprint from the last part of STEVIN's *Mémoires*. Originally written in Dutch it is said that there was also a separate Dutch edition but no copy of the latter has yet been found. It is probable that that separate edition was simply a reprint with separate title page of the second part of the fifth volume of the *Wisconstighe ghedachtenissen*. A revised edition of the Dutch text appeared in the *Materiae politicae* (1649). A Latin version by SNEL is included in the *Hypomnemata*. The French translation was made

---

further explanation is given, nor is any source indicated, but I assume that the information is taken from ISAAC BEECKMAN's diary of which DE WAARD is preparing an edition.

(33) In reality it is problem 18 of Book II (TANNERY's edition, 1, 110-113, 1893.)

by JEAN TUNING. It was not reprinted in GIRARD's *Œuvres*.

This treatise on bookkeeping " in the Italian manner," (i.e., in partita doppia, double entry) was composed by STEVIN at the request of Prince MAURICE, and aptly dedicated to SULLY, the great French economist and minister to HENRI IV. It is divided into two parts : The merchant's account book, and the prince's account book, and the latter part is subdivided into three others : Livre de compte en domaine, livre de compte en dépenses, livre de compte en finances extraordinaires.

For another work of STEVIN's on the same subject see the note below on the *Materiae politicae*.

The earliest treatise on double-entry bookkeeping was the *De computis et scripturis* (36 chapters) included in the *Summa de arithmetica* of LUCA PACIOLI (Venice 1494) and this was the fountain head of all ulterior publications, but if PACIOLI was the first expositor of the subject he was by no means the inventor of it. It is probable that that method was invented in northern Italy. In any case the earliest examples of it have come down to us from that country : accounts of the stewards of Genoa 1340; MEDICI accountbooks, Florence 1395; ledgers of the firm DONADO SORANZO and brothers, Venice 1410. (34) These methods were perhaps somewhat different; PACIOLI said he explained the " Venetian " one.

The Italian method was introduced into the Low Countries, Germany, and England by means of a number of sixteenth century books written in Dutch, German, French, English. The bibliography of these books is full of difficulties because the authors were generally insignificant, and because the books themselves were used rather than treasured. (35) For example, the oldest English treatise on the subject, an incomplete but literal translation of PACIOLI by HUGH OLDCASTLE, was printed in London 1543, but no copy of it is extant. It was reprinted in London 1588 by JOHN MELLIS : it is MELLIS himself who tells us that OLDCASTLE's book was printed in London on August 14, 1543 and that he used it for thirty years ! These matters being of anti-

(34) For Genoa and Venice, see BROWN (1905, 99). For Florence, see ALBERTO CECCHERELLI : *I libri di mercatura della banca* MEDICI (Florence 1913).

(35) Much information may be found in BROWN (1905); also, less completely but with additional facsimiles, in GEIJSBEEK (1914).

quarian rather than of scientific interest, we may pass them over.

Suffice it to say that STEVIN was not the introducer of double entry bookkeeping into northern Europe, not by any means. On the contrary he had many obscure predecessors. His interest in the subject was natural enough for did he not begin his career as cashier and bookkeeper in Antwerp? An analysis of the sixteenth century literature on bookkeeping would show that Antwerp played an important part in the diffusion of the Italian method, as might well be expected considering her commercial supremacy in that century.

It is not even correct to say that STEVIN was the first to make a distinction between personal and impersonal (princely, municipal or national) accounts—for this had been done all along in Italy—but he emphasized the need of separating these accounts and of applying the same methods to both, and he was able to draw attention to his views in the proper places thanks to his intimate relationship with prince MAURICE and his dedication to SULLY. Apparently he was the first man to perform duties comparable to those of a public accountant and to rationalize those duties. He was keenly aware of the necessity of introducing internal checks into the accounts in order that the auditing might be easier and deeper.

The origin of his treatise is clearly explained in the dedication to SULLY and in two preliminary dialogues. He recalls his experience as a bookkeeper and cashier in an Antwerp firm and his work in the financial administration of his native city. While doing this work he was struck by the fact that the domanial and financial accounts were kept so badly that princes were always at the mercy of their intendents and receivers, who could deceive them with impunity. It was very soon clear to him that the only way to put a stop to those abuses was to introduce into the public or princely administration the very methods used by merchants, but he had no chance to set forth his views to a competent person until the day came when MAURICE OF NASSAU asked for his advice in that very matter. STEVIN explained his ideas of reform to him, and composed the first part of his work; MAURICE then asked him to compose the second part (i.e., the prince's accountbook). The Prince understood at once the

advantage of STEVIN's method and introduced it in his own domains (1604).

26. (S. 145, 146, 147, 148, 149). *Castrametatio, dat is Legermeting* (4 l., 56 p.) *Nieuwe maniere van sterctebov door spilsluysen* (2 l., 62 p.) Rotterdam 1617. For title-pages, see figs. 19-20.

These two parts are meant to go together as a single book, but they are sometimes found separate. Each has its own pagination, title page, and preface; the first preface is dated The Hague, November 4, 1617, and the second, The Hague, December 21, 1617.

The first part deals with castrametation, that is the art of laying out a military camp, with special regard to the customs and needs of the Prince of Orange. The second is devoted to the construction of sluices and the deliberate use of sluices in fortifications for defensive purposes. Sluices were useful also to maintain a proper level of water in the moats. These moats were important in peace as well as in war time for ships took refuge in them in bad weather or when the river was made unsafe by floating ice. Of course sluices had been known for centuries, but STEVIN may have improved their construction (fig. 30) and at any rate his treatise was one of the earliest on the subject, and contained the very first explanation of their use for tactical purposes, that is, for flooding the country and thus causing it to become inaccessible to the enemy. It is interesting to recall that during the great war the Belgian army availed itself near Nieuwpoort of the very method which their illustrious countryman had been the first to expound three centuries before. This treatise was much praised by general BRIALMONT.

Both parts were reprinted in the same style (i.e., with separate paginations) and with the same figures in Leiden 1633.

French translation in the same style entitled *La Castramétation* (fig. 21) ... *Nouvelle manière de fortification par écluses.* Rotterdam 1618. There is a copy of this edition in the Harvard Library. This translation was published by the same printers as the Dutch original edition and it includes the same illustrations, notably the portrait of Prince MAURICE, which is here reproduced. The translator is not named; in fact the book is not called a translation, and both prefaces are signed by SIMON STEVIN, and bear the same date, The Hague, March 12, 1618. It is possible that STEVIN made the translation himself.

There were two other French editions in the same year : one in Leiden, by the Rotterdam printer, the other in Leiden, by the ELZEVIERS,—both editions bearing the ELZEVIER imprint. The text was reprinted in GIRARD's *Œuvres mathématiques.*

There is also a German translation at least of part two : *Wasser-Baw. Erstlich in Niderländischer Sprach beschrieben... Anjetzo aber durch einen Liebhaber ins Hoch Teutsch ubersetzt.* Franckfurt, 1631.

This completes the list of the books published by STEVIN and of their later editions; we shall now consider the *Œuvres* published by GIRARD and other posthumous publications.

27. (S. 150). (Bastard title). *Les Œuvres mathématiques de* SIMON STEVIN *augmentées par* ALBERT GIRARD.

(Title page). *Les Œuvres mathématiques de* SIMON STEVIN *de Bruges où sont insérées les Mémoires mathématiques esquelles s'est exercé le... Prince* MAURICE DE NASSAU... *Le tout reveu, corrigé et augmenté par* ALBERT GIRARD, *Samielois* (36), *Mathématicien* (folio, 4 l., 224 + 680 p.) Leiden, ELZEVIER, 1634. For title-page, see fig. 22.

ALBERT GIRARD was born at Saint Mihiel, Lorraine, in 1595; he spent a good part of his life in the Netherlands and died at the Hague, 1632. (37) The *Œuvres* were thus posthumous with regard to the editor as well as to the author. The dedication to " Messeigneurs les États Généraux de Païs Bas Unis " and to " Monseigneur le Prince d'Aurenge " (38) is signed by GIRARD's widow and children. He left behind eleven children. GIRARD was himself a great mathematician, and he added many observations of his own to the Stevinian text : these observations can be easily distinguished from the rest. Some works were translated by TUNING or STEVIN, others were translated by himself and abbreviated; his own additions are always specifically mentioned as such. Hence the *Œuvres* can be used to study STEVIN's own thought, but one must be careful not to ascribe GIRARD's unmistakable interpolations to STEVIN (39).

(36) That is, of Saint Mihiel.

(37) For GIRARD's life see CORNELIS DE WAARD's article in *Nieuw Nederlandsch biografisch woordenboek* (vol. 2, 477-81, Leiden 1912).

(38) Not STEVIN's patron, MAURICE, who died in 1625, but MAURICE's younger brother, FREDERIK HENDRIK, stadhouder from 1625 to 1647.

(39) For a more detailed discussion of the differences between the STEVIN text and the STEVIN-GIRARD text see BOSMANS (1926, p. 5-9).

It will suffice to indicate briefly the contents of the *Œuvres*. They are divided into six volumes, generally bound in one; vol. 2 to 6 have a continuous pagination.

Vol. 1. Arithmétique. This includes the Appendice algebraique, p. 88-9 (see § 15). Vol. 2. Cosmographie : Doctrine des triangles (TUNING's translation in *Mémoires*, minus the tables). Geographie et Astronomie, translated by GIRARD. Vol. 3. Practique de géométrie. Books 1 to 4 are TUNING's translation, books 5-6, GIRARD's. Vol. 4. Art pondéraire ou statique. GIRARD's translation, which is not quite as faithful as SNEL's Latin version. Vol. 5. Optique. Book I was translated by TUNING, book II by GIRARD. Vols. 2 to 5 are a French translation of the *Wisconstighe ghedachtenissen*, that translation being either the one already published by TUNING in the *Mémoires mathématiques*, or GIRARD's own version. Vol. 6. Fortification. In three parts. Parts 1 and 2 are the items of § 26; part 3, GIRARD's version of the item of § 16 . There is nothing new in GIRARD's *Œuvres* except his own notes, but it is a very convenient edition of STEVIN's works, and probably the one which is used by most scholars.

28. (S. 151). *Materiae politicae. Burgherlicke stoffen. Vervanghende ghedachtenissen der oeffeninghen des... Prince van Orangie. Beschreven deur zal.* SIMON STEVIN... *En uyt sijn naghelate Hantschriften bij een ghestelt deur sijn soon* HENDRIK STEVIN (2 vols., very complicated pagin.) Leiden n.d. (1649). For title-page, see fig. 23.

After STEVIN's death his manuscripts were not handled with sufficient care by his widow and his elder son, FREDERIK (1613-39). When his second son, HENDRIK inherited them he found them in great disorder. Some of them had found their way into other hands, for example, in those of ISAAC BEECKMAN (1588-1637) (40), who had made copies of them. HENDRIK obtained these copies (or the originals ?) through ISAAC's brother, ABRAHAM. He tried to put all these papers in order and began a publication of them in 1649. Only these two volumes have appeared. Their dedication is dated Alphen, February 1649. As the *Materiae politicae*

(40) On ISAAC and ABRAHAM BEECKMAN, see notes by CORNELIS DE WAARD : *Nieuw Nederlandsch biografisch woordenboek* (vol. 7, 84-88, 1927).

do not contain much which would be of direct interest to the historian of science, my description will be very brief. All these writings are in Dutch, but for the sake of simplification I shall not quote the Dutch titles except in one case.

Vol. 1 contains a series of eight memoirs on administrative and military matters. 1. Description of a model town and a model house (128 p.) 2. New edition of the *Vita politica*, 1590 with the appendix included in the Middelburg edition of 1658 (p. 1-45). 3. Organization and hierarchy of different administrative bodies and authorities (p. 47-86). 4. Administrative ethics; means of selecting good officials (p. 87-121). 5. Rules for diplomatic correspondence and records (p. 123-41). 6. Retaliations in peace time (p. 143-52). 7. Necessity of moving garrisons frequently, and the keeping of adequate records to facilitate periodical movements of that kind (p. 153-73). 8. Non-mathematical parts of the military art (p. 175-273).

Vol. 2. Sometimes found separately with the title *Verrechting van domeine mette contrerolle en ander behouften vandien.* Leiden, " In 't tweede Iaer des Vredes " (In the second year of the peace (41), i.e., 1649). This contains only two items, both dealing with financial matters. The first is the *Verrechting van domeine.* Reform of the domanial administration (4 l., 156 p.). The second, *Vorstelicke bouckhouding in domeine en finance extraordinaire op de italiaensche wyse* (complicated pag., total 274 p.) This second part is a revised and enlarged edition of the Dutch version of the *Livre de compte de prince* in the *Wisconstighe ghedachtenissen.*

Parts of this vol. 2 have been reproduced in facsimile in GEIJSBEEK (1914, 114-36).

Another " title " edition of the *Materiae politicae* was published by the same printers, but by another publisher in Leiden 1649 (S. 152). A real second edition appeared in The Hague 1686.

29. (S. 153). HENDRIC STEVIN : *Wisconstich filosofisch bedryf* (one vol. quarto, very complic. pagin.) Leiden 1667 (fig. 24). *Plaetboec* (folio atlas accompanying the vol. of text) Leiden 1668.

The author of this work is not SIMON, but his son HENDRIK.

(41) Reference to the Treaty of Münster (Jan. 1648) between Holland and Spain, wherein the latter finally recognized the independence of the United Provinces.

However, the latter refers frequently to the former and quotes fragments from his unpublished writings, e.g., on the construction of windmills, (42), on the keeping in repair of harbors and waterways, on the impossibility of perpetual motion.

I have not seen this work and only know it through the description given in the *Bibliotheca belgica*, wherein the Dutch titles of each part are given. However, these titles are not always sufficiently clear to warrant translation without the context. Brief and incomplete as my analysis is, it will suffice to indicate the nature of this collection.

1. Explanation of the publication of this work, including biographical information. 2. Resistance of solid bodies, such as cords, beams, columns, axles. 3. Statics. 4. Cinematics. Includes an exchange of letters (1618) between SIMON STEVIN and I. L. HOSTE, mathematician to the Duke of Lorraine: HOSTE thought he had found a means of creating a perpetual motion, and STEVIN proves that he is wrong. 5. Van de schampige beweging. 6. Van alder volmaecste cammen en staven (on the best materials for the construction of windmills). 7. Van rechtschape reetschap van gewelt. 8. Vant onfeylbaer uyrwerk te water en te land (on an infallible clock for use on land or at sea). 9. On an unsinkable ship. 10. On windmills. This seems to be SIMON's own work; in any case it refers to his own inventions patented in 1586 or 1588. Another treatise on windmills by SIMON as preserved by A. BEECKMAN. 11. Documents and remarks concerning the works to be undertaken in various cities to improve their harbors and waterways. Much of this concerns SIMON directly. The cities involved are Danzig, Elbing, Braunsberch, Deventer, Rheinberg, Schiedam, Lingen, Calais, Leiden. 12. More hydraulic projects. This includes two chapters by SIMON on pumps. Some of HENDRIK's schemes were very bold (see prop. 25); he suggested drying up the sea of Haarlem, building a dam in the Ij and draining part of it, digging a canal from Amsterdam to the North Sea, draining the Zuiderzee. Some of these projects have actually been realized, the last one is in the process of realization in our own days. 13. Theological and philosophical

(42) They are called " watermolens " (watermills) but they are really windmills used for pumping water. The Dutch term refers to their function, the English to the driving power.

topics. 14. Van de wisconstige burger en crychvolcstier. 15. Appendix, containing various corrections.

30. *De spiegeling der singconst* (Mirror of the art of singing). Edited by DAVID BIERENS DE HAAN (1822-95), in the latter's Bouwstoffen voor de geschiedenis der wis- en natuurkundige wetenschappen in de Nederlanden, no. XXVI (*Verslagen en mededeelingen der koninklijke Akademie, Afd. Natuurkunde*, 20, 102-95, Amsterdam, 1884).

This is the treatise on music which STEVIN had planned to publish in vol. 5 of his *Wisconstighe ghedachtenissen* (see § 24). In fact it is entitled " Derde deel der ghemengde stoffen vande spiegeling der singconst " (third part of the miscellanea, etc.).

31. *Van de molens* (about windmills). Edited by the same in same series no. XXVII (*Ibidem*, 197-232).

This treatise by SIMON STEVIN was revised by one Professor GOLIUS in 1634. Calculations concerning 19 windmills.

Both items 30 and 31 have also been reprinted by BIERENS DE HAAN in a separate volume. SIMON STEVIN : *Deux traités inédits* (Amsterdam 1884), wherein he has replaced his Dutch prefaces of the original academic edition by French prefaces.

32. *Unpublished manuscripts.* For information on the STEVIN's MSS. see *Bibliotheca belgica*, note S. 151, p. 8-15 and the end of BOSMANS' notice in the *Biographie nationale de Belgique* (1924). Some of STEVIN's texts will eventually be published in BEECKMAN's Diary to be edited by CORNELIS DE WAARD. However, it would seem that the essential of SIMON STEVIN's abundant production is already available in print. In fact the very best was already available in STEVIN's time, and the posthumous publications which we owe to the piety of his son and of BIERENS DE HAAN have added but little to his fame.

III. — STEVIN'S ACHIEVEMENTS

His mathematical sources

33. Before dealing with STEVIN's mathematical discoveries, it is well to say a few words of his mathematical learning. We may assume that he was tolerably well acquainted with the Greek masterpieces available in Latin. He knew especially well EUCLID and DIOPHANTOS. Among the Arabic mathematicians, he knew

AL-KHWĀRIZMĪ, as translated by ROBERT OF CHESTER. He was familiar with the writings of his older contemporaries the Italians CARDANO, TARTAGLIA and BOMBELLI, and the Portuguese PEDRO NUÑEZ, but apparently not with those of the German mathematicians except MICHAEL STIFEL and perhaps CHRISTOFF RUDOLFF. (43)

Arithmetic

34. First systematic explanation of decimal fractions and extension to them of the fundamental operations (1585). (44) Unfortunately the beauty of this innovation was hidden by cumbersome notations.

First suggestion of the extension of the decimal idea to weights and measures (1585).

These two very important items will be fully discussed in a separate paper.

35. Publication of the earliest printed tables of interest (1582).

36. Insistence on the separation of princely or government accounts from the personal ones and application of the Italian methods, i.e., double-entry bookkeeping, to both (1608). STEVIN was not the first to do this (45), but he worked out these ideas in great detail and recommended their adoption to Prince MAURICE and to HENRI IV's minister, SULLY.

Algebra

37. Rules relative to equations can be generalized if signs are attached to the numbers : e.g., one can then speak of adding $(-b)$ to a instead of subtracting b from a. They can be generalized as well if one admits that some coefficients may be null (incomplete equations).

(43) FLORIAN CAJORI : *History of mathematical notations* (vol. 1, 157, 1928).

(44) These dates refer to STEVIN's publications which can be easily identified by reference to the list given above. In 1585, and also in 1594 he published more than one book but on such different subjects that no ambiguity is possible. For subjects dealt with in the *Hypomnemata* the date is sometimes given as 1605, sometimes 1608 (see note in section 19).

(45) Not to speak of the Byzantine financial administration which was highly technical, sound ideas on state accounts and budgets had been developed by Oriental authors many centuries before STEVIN. See for example the *Siyāsat-nāma* composed in Persian by NIẒĀM AL-MULK in 1092. Extract translated into French by CARRA DE VAUX : *Les penseurs de l'Islam* (vol. 1, 314-5, 1921). SARTON : *Introduction* (vol. 1, 780).

That the addition of *(—b)* is the same as the subtraction of *b* had already been stated by STIFEL (*Arithmetica integra* 1544) and CARDANO (*Ars magna* 1545), but STEVIN was the first to make use of this for the generalization of the solution of equations.

On that basis STEVIN generalizes the rules relative to the solution of quadratic, cubic, and biquadratic equations. However, the cubic equation must first be reduced to the form $x^3 = px + q$.

The treatment of equations must be purely algebraical, i.e., free from geometrical considerations. (1585).

38. Interpretation of negative roots of equations as the positive roots of the equation obtained by the substitution of *(—x)* for *x*. Hence every equation of the second degree whose roots are real, has two roots (1585).

That interpretation was already expressed by CARDANO with respect to cubic equations (*Ars magna*, 1545). For STEVIN's views see GIRARD's edition, p. 77.

39. Rule for the solution of numerical equations of any degree. (46) Given the equation $f(x) = 0$, if $f(a) > 0$ and $f(b) < 0$, there is at least one root between *a* and *b*.

STEVIN shows how the decimals of the root can be obtained by successive approximations, and he remarks that in some cases the true value cannot be reached though one can obtain as many decimals of it as one may wish and come indefinitely near to it (1594).

40. Modern definition of polynomials (*Arithmétique*, book I, def. 26). Solution of the problem : to find the greatest common divisor of two polynomials (ibidem, book II, problem 53) (1585).

Geometry

41. Generation of an ellipse by lengthening the ordinates of a circle in the same proportion (1605).

Scénographie, article VI (GIRARD, p. 549).

42. Solution of particular cases of the inverse problem of perspective : Given two figures in a plane which are perspectives of one another, place them in space and determine the eye's position (1605).

Scénographie, Invention de l'œil (GIRARD, 550, etc.) See MICHEL CHASLES : *Aperçu historique* (Bruxelles, 1837, 347).

(46) Needless to say no equations are meant other than rational and integral polynomials equalled to zero.

If the perspective (or picture) plane rotates around the ground line and the spectator rotates around his basis, remaining all the time parallel to the plane, the perspective will not be disturbed; it will still exist when the perspective plane is horizontal (1605).

Scénographie, Theor. V, Prop. VII (GIRARD, p. 533). GINO LORIA : *Storia della geometria descrittiva* (Milano 1921, 21, 215).

Trigonometry

43. Reduction of the trigonometrical formulas relative to right-angled spherical triangles to six, and an explicit statement that these six formulas are sufficient to solve all problems (1608).

A. v. BRAUNMÜHL : *Vorlesungen über die Geschichte der Trigonometrie* (vol. 1, 227, 1900).

Analysis

44. The method of exhaustion as applied by ARCHIMEDES, involving a *reductio ad absurdum*, is replaced by a direct passage to the limit, e.g., in the determination of centers of gravity (1586).

Thus STEVIN is one of the links in the gradual transformation of the Greek method of infinitesimal analysis into the modern one, the chain being as follows : ARCHIMEDES, COMMANDINO, STEVIN, GRÉGOIRE DE SAINT VINCENT, GUILLAUME BOELMANS, ANDRÉ TACQUET, PASCAL, LEIBNIZ. Another chain was ARCHIMEDES, LUCA VALERIO, KEPLER, CAVALIERI, LEIBNIZ. These chains were not independent for there were contacts between VALERIO and SAINT VINCENT, and perhaps between STEVIN and KEPLER.

STEVIN's *mechanical sources*

45. STEVIN was acquainted with the *Μηχανικὰ προβλήματα* ascribed to ARISTOTLE; with ARCHIMEDES, PAPPOS; JORDANUS NEMORARIUS—the *Liber* JORDANIS *de ratione ponderis* was printed in Venice 1565 (47); LEONARDO DA VINCI (via CARDANO), and TARTAGLIA. He was probably acquainted with GIAMBATTISTA BENEDETTI's early work through JEAN TAISNIER, but it is unlikely that he knew already in 1586 BENEDETTI's main work, the *Diversarum speculationum mathematicarum et physicarum liber* (1585) wherein

(47) SARTON : *Introduction* (2, 615).

some of his hydrostatic ideas were anticipated : a year is but a very short time for a work printed in Torino to reach the Low Countries in the midst of war. He may have known the *Mechanicorum liber* of GUIDO UBALDO DEL MONTE (Pisauri 1577).

Statics

46. Simple demonstration (different from the Archimedean) of the condition of equilibrium of a horizontal lever with unequal arms (1586). It is true this demonstration had been known implicitly (48) for a considerable time,—perhaps already in Hellenistic days. A similar demonstration reappears in GALILEO's *Discorsi e dimostrazioni* (1638), and in later writings.

It should be noted that STEVIN's demonstration is not essentially better than that of ARCHIMEDES, for he makes use of the center of gravity, the determination of which implies the principle of statical moment. However, his attempt to improve the epistemological foundation of statics is significant. (49)

47. Very simple and original demonstration of the law of equilibrium on an inclined plane based upon the postulate of the impossibility of perpetual motion (1586).

Hence are implicitly deduced : the general law of composition of concurring forces (parallelogram of forces), the decomposition of a single force (e.g., the weight of a body) into two normal components (see also *Spartostatica*, 1605).

48. STEVIN did not actually recognize the principle of virtual velocities, already vaguely expressed in the Peripatetician physics and developed during the Middle Ages by Muslim and Christian mechanicians, but he accepted a principle somewhat differently represented by these two Latin lines.

Ut spatium agentis, ad spatium patientis :
Sic potentia patientis, ad potentiam agentis (50).

These two principles were often confused in the sixteenth century but STEVIN was very clearly in favor of virtual displacements

(48) It is found explicitly in a thirteenth century MS. (Bibl. Nat. Paris, fonds latin, 7377B) quoted by DUHEM (1905, 1, 287-9).

(49) For another criticism of ARCHIMEDES see V. F. LENZEN : ARCHIMEDES' theory of the lever (*Isis*, 17, 288-89, 1932).

(50) Quoted in his *Trochleostatica* (1605, p. 172) and called by him a " staticum axioma."

as against virtual velocities; in this he was followed by DESCARTES. On the contrary GALILEO continued in this respect the Peripatetician line of thought.

49. Representation of forces by vectors. (Was STEVIN truly the first to do this?).

Hydrostatics

50. Restatement of the fundamental principle of hydrostatic equilibrium—" Aquam datam, datum sibi intra aquam locum servare " (51)—established upon the postulate of the impossibility of perpetual motion.

Hence are deduced the laws of hydrostatic pressure and their application to the study of communicating vessels and floating bodies and finally the hydrostatic paradox (1586).

Similar conclusions with regard to communicating vessels and even to the principle of the hydraulic press were published a year earlier by GIAMBATTISTA BENEDETTI in a letter " De macina quae aquam impellit et sublevat " included in his *Diversarum speculationum mathematicarum et physicarum liber* (Torino 1585, 287-8) but STEVIN's work was in all probability independent of this. (52)

51. There has been some discussion as to whether STEVIN was the discoverer of the hydrostatic paradox or not. It has been claimed, on the one hand, that it was already implied by ARCHIMEDES, who discovered the general law of which the hydrostatic paradox was but a paradoxical consequence; on the other hand (by SCHOR) that for a clear recognition of it we must wait until PASCAL (*Traitez de l'équilibre des liqueurs*, Paris 1663). I believe that both claims are wrong : one cannot give credit to anybody for implications, but only for explicit statements, especially not when the implication is somewhat paradoxical. On the other hand though STEVIN did not understand the paradox as deeply as PASCAL, nor express it as neatly (as far as expression is concerned STEVIN was but a stammerer as compared with PASCAL),—yet

(51) I quote the Latin translation from the *Hypomnemata* (vol. 4, 114). The original text was in Flemish (1586).

(52) The most elaborate study on BENEDETTI is GIOVANNI BORDIGA : GIOVANNI BATTISTA BENEDETTI, filosofo e matematico veneziano del secolo XVI (*Atti del R. Istituto Veneto*, t. 85, p. 2da, 585-754, 1926; see p. 718).

he was clearly aware of it and suggested experimental verifications of it.

An excellent vindication of STEVIN was made by no less a person than LAGRANGE in his *Méchanique analitique* (Paris 1788, première partie, section 6) (53).

Let us read STEVIN. I cannot refer to the Dutch text of 1586 which is not available to me, but see *Hypomnemata*, t. IV, p. 119.

" 8 Theorema 10 Propositio. Aquae fundo horizonti parallelo tantum insidet pondus quantum est aquae columnae cujus basis fundo, altitudo perpendiculari ab aquae superficie summa ad imam demissae aequalis sit."

Then see *Hypomnemata*, t. IV, p. 145.

" Exemplis pragmaticis 10 propositionis hydrostatices veritatem comprobare." In this place there is a good statement of the hydrostatic paradox, and of the experimental verification of it, and the application of it which led later to the hydraulic press (54) is unmistakably indicated. For the French translation of these texts see the *Œuvres mathématiques* edited by GIRARD (vol. 2, 487, 498).

STEVIN's priority over PASCAL with regard to the hydrostatic paradox is also established by the testimony of contemporaries : see the memorandum prepared by DESCARTES for ISAAC BEECKMAN in 1618 and preserved in the latter's diary and MERSENNE's remarks in his *Vérité des sciences* (Paris 1625, p. 231) concluding that under certain circumstances " un sceau d'eau peut autant peser comme fait toute l'eau de la mer " (55).

52. Approach to the notion of metacentrum in his treatise on topheavy floating bodies (De fluitantibus acrobaricis) added to the second edition of the Statics (*Hypomnemata*, vol. 4, 177-80, 1605). See our fig. 29.

(53) *Œuvres de* LAGRANGE (vol. XI, 191-2, 1888). According to DUHEM, STEVIN deserves even more credit than LAGRANGE was willing to give him; he should be considered " the inventor of the true foundations of hydrostatics." P. DUHEM : ARCHIMEDE connaissait-il le paradoxe hydrostatique ? (*Bibliotheca mathematica*, 1, 15-19, 1900). D. SCHOR : STEVIN und das hydrostatische Paradoxon (*Ibidem*, 3, 198-203, 1902).

(54) Or " Bramah " press, patented by JOSEPH BRAMAH (1748-1814) in 1795.

(55) For DESCARTES, see *Œuvres* (ADAM et TANNERY, vol. 10, 67-74, 1908). For MERSENNE, his *Correspondance publiée par Mme.* PAUL TANNERY (vol. 1, 313, 1933). MERSENNE quotes STEVIN, DESCARTES does not, but the source of his reflexions was undoubtedly the same.

The metacentrum was first defined and named by PIERRE BOUGUER (1698-1758) in his *Traité du navire, de sa construction et de ses mouvemens* (Paris, 1746, 257).

Navigation

53. Scientific comparison of the two fundamental methods of navigation : sailing along a great circle and sailing along a loxodrome (56) (De histiodromia, 1608).

The history of the loxodromes (curves cutting all the meridians under the same angle) begins with PEDRO NUÑEZ, who was the first to have a clear idea of them and to show that they were spirals coiling round but never reaching the poles (1537). NUÑEZ was not able to draw correctly a loxodrome on a map, and there is no Portuguese map with correct loxodromes anterior to MERCATOR. The latter's globe of 1541 was the first correct application of them to cartography. (57)

The use of the MERCATOR projection made the drawing of loxodromes very easy, as these were projected as straight lines. The earliest known example of the MERCATOR projection is MERCATOR's planisphere of 1568-69, but it was only approximately correct up to the latitude of 40°. The construction was empirical : MERCATOR probably noted where the loxodromes cut the meridians on a sphere and placed his parallels on the map accordingly. The first attempt to solve the problem mathematically (as much as this could be done without the resources of the calculus) was made by EDWARD WRIGHT (1558?-1615) : WRIGHT's principles were applied with acknowledgment by THOMAS BLUNDEVILLE in London 1594 and without acknowledgment by JODOCUS HONDIUS in Amsterdam, c. 1597; WRIGHT finally published them together with tables ad hoc in his *Certaine errors in navigation* (London 1599) (58).

The loxodrome was at first called linea rhombica, rumbus, rhumb or rhumb line. CANTOR says that the word loxodrome

---

(56) S. GÜNTHER (1879, 345, 363, 395).

(57) HERMANN WAGNER : Die loxodromische Kurve bei MERCATOR (*Nachrichten, Kgl. Ges. d. Wiss., Göttingen*, 254-67, 1917; *Isis*, 4, 591).

(58) M. BLUNDEUILLE *his Exercises containing sixe treatises* (London 1594). JODOCUS HONDIUS' map called *Typus totius orbis terrarum* (c. 1597). MOTTELAY (1922, 559-64).

was introduced by WILLEBRORD SNEL in his *Tiphys Batavus* of 1624 (59). This statement is not correct. We find that word already in STEVIN's treatise on the Histiodromia (1605),—but the Latin translator of that treatise was SNEL himself. Hence SNEL may have been the introducer, instead of STEVIN (I have no access to the Dutch text), but in any case he introduced them in STEVIN's work, and the date is 1605, not 1624. The word loxodrome is opposed to the word orthodrome, referring to a great circle.

" Histiodromiae subjectum quatuor definitionibus et undecim propositionibus expedivimus, earum duae priores ὀρθοδρομίαν seu rectas velificationis lineas, caeterae λοξοδρομίαν seu curvas explicabunt " (*Hypomnemata*, vol. 1, part. 2, 84, 1605).

This treatise includes " canones loxodromici " enabling the navigator to construct loxodromes point by point on a globe. These tables were an improvement upon the tables of meridional parts compiled by EDWARD WRIGHT (who is duly named in the introductory statement,) and they were considerably elaborated by SNEL in his *Tiphys Batavus* of 1624.

STEVIN suggested the use of metallic " curves " (curved rulers) for the drawing of loxodromes on a sphere. (De loxodromicarum cuprearum helicum fabrica. *Ibidem*, p. 138).

54. Method of identifying harbors by the determination—in addition to the latitude—of magnetic declination, the direction of the true north being found by the observation of two equal altitudes of the sun (1599).

According to STEVIN's own statement credit for this method should be given in the first place to the geographer PETRUS PLANCIUS (see above section 17); in any case PLANCIUS it was he who obtained the data collected in *De Havenvinding*. STEVIN quotes in the same book (1599) one REGNIER PIETERSZOON (REGINALDUS PETRAEI) as the inventor of a special model of quadrant, but he makes no reference to anybody else, not even to WILLIAM BOROUGH (1536-99) English navigator who appended to the *Newe Attractive* by ROBERT NORMAN (London 1581) a " *Discourse of the variation of the cumpas, or magneticall needle, wherein is mathematically*

(59) *Tiphys batavus sive histiodromice, de navium cursibus et re navali* (Leiden 1624). CANTOR : *Vorlesungen* (II2, 707, 1900).

shewed the manner of the observation, effects, and application thereof." BOROUGH gave many observations of variation and remarked that nearly all the contemporary charts including MERCATOR's famous planisphere of 1569, were full of errors because the cartographers had failed to take variation into account. The *Discourse* was reprinted at least three times : 1585, 1596, 1611, 1614 (?). Thus three editions appeared before the *Havenvinding*. However, it is possible that STEVIN had not heard of it.

Theory of tides

55. General theory of tides in the sixth book of the geography : De theoria maritimorum aestuum in accessu et recessu (*Hypomnemata*, vol. I, part II, p. 175-188, 1608.)

STEVIN and later KEPLER expressed their belief in the importance of lunar attraction as a tidal factor. STEVIN tried to develop a mathematical theory of this; he was more cautious in his conclusions than KEPLER. The latter's belief in the magnetic influence of the moon was an object of derision to GALILEO whose fear of astrological explanations led him to deny the possibility of any lunar influence on the tides. STEVIN's and KEPLER's theories, imperfect as they are, constitute the most important progress in the theory of tides before NEWTON's *Principia*.

STEVIN indicates a rough means of calculating the beginning of ebb and flow from lunar observations. At the end of his book (Prop. 9. Quomodo aestuum maritimorum cognitio planius indigari possit) he insists upon the necessity of obtaining abundant experimental data in order to be able to improve the mathematical theory of tides and their prediction in definite places. He also suggests (*ibidem*) making an experimental study of tides in a small and remote island, such as St. Helena, where the general phenomena would not be disturbed by continental influences.

Geology

56. The second book of STEVIN's geography printed in the *Hypomnemata* (vol. I, part II, p. 47-67, 1605) entitled " De hylocinesi terrestris globi " is truly a geological treatise. According to the first definition (p. 51) " Terreni globi hylocinesis, est variarum materiarum, è quibus coagmentatus est, motus in suo loco, figura totius manente sphaerica."

In plain English the term " hylocinesis " refers to the internal changes of the materials constituting the earth. STEVIN's treatise is a summary of physical geology discussing the changes in the surface of the earth and the forces which produce them.

His views might be roughly described as uniformism (as opposed to catastrophism) : he explains past changes by the action of forces which we may observe with our own eyes. His account of the formation of mountains is incorrect because he had but little if any knowledge of them; he was very familiar with dunes and was deceived by a false analogy between dunes and mountains. He gives accounts of many physical actions which modify the face of the earth : wind, rain, snow, running waters, evaporation, alluvions, sedimentations (and how these are affected by the varying speed of a stream), water infiltrations, incrustations, petrifications. He had noted the difference in the profiles of the two banks of a river, and the gradual development of its meanders; the alternations of lands and sea; he makes curious remarks on the dissolution of all kinds of earths and minerals in water, on the destruction and " growth " of rocks and metals, etc. Correct interpretation of fossil shells. His explanation of peat deposits is incorrect.

Similar ideas are found in the Arabic and Latin writings of the Middle Ages. (60) A more detailed inventory of them than has yet been attempted would be needed to determine exactly the amount of novelty of STEVIN's views. According to ZITTEL (61), STEVIN's book was the first systematic treatment of the subject, but such a statement remains doubtful and meaningless, until a comparative analysis has been made of that book and of various mediaeval summaries.

Technology

57. Improvements in the construction and use of sluices (canal locks) and application of sluices to the defense of fortified places (1617). See my preliminary discussion of this in my account of STEVIN's *Castrametatio* in § 26 (Fig. 30).

Sluices were possibly invented as early as the time of PTOLEMAIOS II (middle of the third century B.C.), and we may

(60) SARTON : *Introduction* (vol. 2, 48).

(61) ZITTEL (1901, 186).

expect their development to have been especially rapid in countries such as Holland, where the need of them was greatest. According to DARMSTAEDTER and FELDHAUS (62) a sluice with gates at both ends (lockchamber, Kammerschleuse, kolksluis) was built in Spaarndam, 1253, by WILLEM OF HOLLAND (This would then be WILLEM II, count of Holland and Zeeland, born 1228). The existence of such a sluice in Holland by the middle of the thirteenth century is plausible; yet I have found no documents confirming it. We have more definite evidence concerning the locks constructed in 1439 by FIORAVANTE OF BOLOGNA and FILIPPO DEGLI ORGANI of Modena. (63) The first clear description of locks was given by LEONE BATTISTA ALBERTI (1404-72) and excellent drawings were made sometime later by LEONARDO DA VINCI.

To return to STEVIN, we find the following information in his treatise of 1617 (I have used the French translation of 1618 published by himself and presumably equivalent to the Dutch original). It is divided into four chapters :

1. De la nouvelle invention d'escluses; 2. De l'affermissement des fonds d'escluses et dodanes; 3. Règle générale de la nouvelle manière de la fortification des villes par escluses; 4. Exemples comment aucunes villes consistantes en effect, se peuvent fortifier par les règles générales du 3 chapitre.

STEVIN's improvements were relative to three purposes : the deepening of harbors, the drying up of low lands, and the transfer of ships with high masts. Smaller improvements concern the construction of foundations, and gates and other technical details. However, the main novelty of his effort consists in its application to fortification.

58. STEVIN improved the windmills which were so extensively used in his country for pumping water out of the polders. In 1586, he received a patent concerning their construction from the States-General. I do not know the exact nature of the improvements which he introduced.

59. He invented a kind of chariot equipped with sails, by means of which a party of 28 people including Prince MAURICE were taken from Scheveningen to Petten along the shore of the

(62) LUDWIG DARMSTAEDTER's *Handbuch* (Berlin 1908). F. M. FELDHAUS : *Die Technik* (Leipzig, 1914, 962).

(63) I shall discuss this in vol. 4 of my *Introduction to the history of science.*

North Sea in two hours, the distance being fourteen Dutch miles (a distance of more than fourteen " hours "); this occurred probably about the end of the year 1600.

This unimportant invention seems to have given him more popularity with his contemporaries than all the rest of his work! It is known through an engraving by JACQUES DE GHEYN representing the chariot (plate 3, fig. 27), with a text in Dutch, French, and Latin, and a poem by HUGO GROTIUS celebrating it. These engravings were first published c. 1612, and many times published and imitated afterwards. A complete set is exceedingly rare. I have never seen them and know them through a description in F. MULLER: *De Nederlandsche geschiedenis in platen. Beredeneerde beschrijving van Nederlandsche historieplaten* enz. (vol. 1, 139-41, Amsterdam 1863-70) and through photostats of a late copy in the British Museum. The title of the copy described by MULLER is " Currus veliferi illustrissimi principis Mauritii volitantes duabus horis Scheverina Pettenum ad quatuordecim milliaria hollandica, quae singula justae horae iter excedunt." (Abbreviated on our fig. 27).

The British Museum copy, dated Amsterdam 1652, is oblong, the three pages of the French text being printed side by side; the three pages of the Dutch side on another sheet, and the two pages of the Latin text on still another. Considering the great rarity of that publication and its relative shortness I reproduce in appendix the French text, entitled " Les artificiels chariots à voiles du comte Maurice." (fig. 25). The Latin text is entitled " Comitis Mauritii Currus artificiales vento acti " (fig. 26) and the Dutch text " Sijn Excell. Graef Maurits kunst-rijcke Windtwagens."

The text which may be read in extenso in its French form below, is curious from the point of view of popular psychology, but its technical interest is negligible. Obviously the man who wrote it was neither technically minded nor intelligent.

To return to STEVIN's sailchariot, it was used again in 1606 by the French savant NICOLAS CLAUDE FABRI DE PEIRESC (1580-1637), who admired it exceedingly. According to JACQUES DE GHEYN's illustration there was also a smaller chariot; the latter was tried as late as 1790, the experiment being unsuccessful, and it could still be examined in Scheveningen in 1802.

See our plate 4, fig. 28 for a view of the chassis of STEVIN's chariot.

60. It is not correct to say as is done in DARMSTTAEDER's *Handbuch* (64) (1908, under year 1605) that STEVIN was the first to illustrate surveying chains. These were first described and illustrated by MELCHIOR SEBIZ : *Siben Bücher von dem Feldbau* (Strassburg 1579, p. 472).

FRANZ M. FELDHAUS : Zur Geschichte der Messkette (*Geschichtsbl. für Technik und Industrie*, vol. 6, 71-72, 1 fig., Berlin 1919).

61. To conclude, STEVIN's main achievements concern the extension of the decimal idea to fractions, and to weights and measures, the theory of algebraic equations, and above all the principles of statics and hydrostatics. He was one of the greatest mathematicians of the sixteenth century and the greatest mechanician of the long period extending from ARCHIMEDES to GALILEO.

IV. — BIBLIOGRAPHY

62. This bibliography is by no means complete, but it contains the essential. For the earlier writings see the *Bibliotheca belgica* (vol. 23, Ghent 1880-90), Father BOSMANS' notice in the *Biographie nationale* (Brussels 1924) or W. VAN DER WOUDE's notice in the *Nieuw Nederlandsch biografisch woordenboek* (Leiden 1921). General reference books such as CANTOR, DARMSTAEDTER, TROPFKE, SARTON are not quoted. There are a few additional references in the footnotes. See also the bibliography included in my second STEVIN paper (section 115).

ALMAGIÀ, ROBERTO : La dottrina della marea nell'antichità classica e nel medio evo (*Acc. dei Lincei, Memorie, sci. fis.*, vol. 5, 377-513, see p. 510. Roma 1905).

BOSMANS, HENRI : Notes sur l'arithmétique de S.S. (*Ann. soc. scient.*, 35, mém. 293-313, Bruxelles, 1911).

— Sur quelques exemples de la méthode des limites chez S.S. (*Ann. soc. scient.*, 37, mém. 171-99, 1913).

(64) The dates concerning STEVIN in that *Handbuch* are generally incorrect.

— La Thiende de S.S. A propos d'un exemplaire de l'édition originale qui a échappé à l'incendie de Louvain (*Rev. quest. scient.*, 27, 109-139, Bruxelles, 1920; *Isis*, 4, 142).
— Remarques sur l'arithmétique de S.S. (*Mathesis*, 36, 23 p., 1922; *Isis*, 5, 223).
— Le calcul infinitésimal chez S.S. (*Mathesis*, 37, 18 p., 1923; *Isis*, 6, 155).
— La résolution des équations du troisième degré d'après S.S. (*Mathesis*, 37, 246-54, 304-11, 341-7, 1923).
— La Thiende de S.S. Facsimile de l'édition plantinienne de 1585 (*Éditions de la Société des bibliophiles anversois*, no. 38, 41+37 p., Anvers, 1924; *Isis*, 7, 543).
— HENRI STEVIN et S.S. (*Biographie nationale*, vol. 23, col. 884-938, Bruxelles, 1924; *Isis*, 7, 542).
— La résolution de l'équation du 4e degré chez S.S. (*Mathesis*, 39, 49-55, 99-104, 145-53, 1925).
— Le mathématicien belge S.S. (*Periodico di matematiche*, 6, 231-61, Bologna, 1926) (65).
BROWN, RICHARD : The history of accounting and accountants (Edinburgh, 1905).
CAPPELLE, JOHANNES PIETER VAN : S.S. en over de wiskundige verdiensten van Prins MAURITS (*Bijdragen tot de geschiedenis der wetenschappen in Nederland*, 1-59, 125-66, Amsterdam, 1821).
DIJKSTERHUIS, EDUARD JAN : S.S. und seine Bedeutung für die Geschichte der Mathematik und Naturwissenschaften (*Unterrichtsblätter für Mathematik und Naturwissenschaften*, 38, 148-50, Frankfurt, 1932).
DUHEM, PIERRE : Les Origines de la statique (2 vols., Paris, 1905-1906). Chiefly vol. 1, 1905.
— Études sur LÉONARD DE VINCI (3 vols., Paris, 1906-1913). Chiefly vol. 1, 1906.
GEIJSBEEK, JOHN BART : Ancient double-entry bookkeeping (182 p., published by the author, Denver, Colorado, 1914).
GODITSKY-TSVIRKO, A. M. : An outline of the history of the

(65) Father BOSMANS has written many other papers which ought to be considered though they do not deal specifically with S.S. See A. ROME : Le R. P. HENRI BOSMANS, S.J. (*Isis*, 12, 88-112, 1929).

funicular polygon (*Publications of the Institute of communication engineering*, 26 p., 23 figs., Leningrad, 1929. In Russian. See *Isis*, 15, 295.

GRAVELAAR, N. L. W. A. : S's Problemata geometrica (*Nieuw archief voor wiskunde*, vol. 5, 106-91, Amsterdam, 1901).

GÜNTHER, SIEGMUND : Geschichte der loxodromischen Curve (*Studien zur Geschichte der mathematischen und physikalischen Geographie*, 333-408, Halle a.S. 1879).

KOKOMOOR, F. W. : The distinctive features of the seventeenth century geometry (*Isis*, 10, 367-415, 379, 1928).

LORIA, GINO : Storia della geometria descrittiva (Milano, 1921; *Isis*, 5, 181-2).

MACH, ERNST : The science of mechanics (Third revised ed., Chicago, 1907).

MARGUET, F. : Histoire générale de la navigation du XV^e^ au XX^e^ siècle (Paris, 1931; *Isis*, 19, 235-37).

MOTTELAY, PAUL FLEURY : Bibliographical history of electricity and magnetism (London, 1922; *Isis*, 6, 104-7).

SCHOR, D. : S.S. und das hydrostatische Paradoxon (*Bibliotheca mathematica*, 3, 198-203, 1902).

STEICHEN, MICHEL : Mémoire sur la vie et les travaux de S.S. (Bruxelles, 1846).

TESCH, J. W. : Waar is S.S. geboren? (*Nieuw archief voor wiskunde*, 3, 94, Amsterdam, 1898).

VINCENT, JEAN : Le système géologique de S.S. (*Annuaire météorologique de l'Observatoire Royal pour* 1901, 355-61, Bruxelles, 1901).

VIVANTI, GIULIO : I principali trattati di algebra dalle origine della stampa al 1800 (*Periodico di matematica*, 4, 277-306, 1924; *Isis*, 7, 314).

WIELEITNER, HEINRICH : Über die Fortschritte, die S.S. in der Lösung der quadratischen Gleichung erzielte (*Sitzungsber. der physik.med. Sozietät zu Erlangen*, vol. 58-59, 177-80, 1926-27).

WOUDE, W. VAN DER; BLOK, P. J. : Articles on HENDRICK and S.S. (*Nieuw Nederlansdch biografisch woordenboek*, vol. 5, 815-8, 1921).

ZITTEL, KARL ALFRED VON : History of geology and palaeontology (London, 1901, p. 186).

Iconography

63. Description of the illustrations of this paper. For the indication of sources, I use the following abbreviations :

BM	British Museum, London.
BRB	Bibliothèque Royale de Belgique, Brussels.
HCO	Harvard College Observatory, Cambridge, Mass.
HL	Henry E. Huntington Library, San Marino, California.
HUL	Harvard University Library, Cambridge, Mass.
LUG	Library University of Ghent.
LUL	Library University of Leiden.
MPM	Museum Plantin-Moretus, Antwerp.

The courtesy of these eight libraries is duly appreciated. I owe special thanks to Dr. ALBERT TIBERGHIEN of Brussels, Drs. L. E. BLISS and R. O. SCHAD of San Marino, Prof. PAUL BERGMANS of Ghent, Dr. MAURITS SABBE of Antwerp and Dr. V. SCHOLDERER of London.

Plate 1, fig. 1. STEVIN's early portrait by an unknown painter (LUL). This portrait is mentioned by E. W. MOES in his *Iconographia batava* (vol. 2, no. 7584, 1905) but no information is given. Nor could any additional information be provided by the Rijksbureau voor kunsthistorische en ikonografische documentatie in The Hague. I thank Mr. L. VAN BLOMMESTEIN for his courteous reply of May 4, 1933.

Plate 2, fig. 2. Portrait of MAURICE, prince of Orange, count of Nassau. Taken from the French *Castrametation*, 1618 (HUL), but the same portrait occurs in the original Dutch edition of the same book, 1617 (not available to me) the same block being presumably used for both editions.

Fig. 3. *Tafelen van interest.* Antwerp 1582 (BRB). See § 8.

Fig. 4. *Problemata geometrica.* Antwerp (1583). See § 9 (BRB).

Fig. 5. *Dialectike ofte Bevvysconst*, Leiden 1585. (MPM). See § 10.

Fig. 6. *De beghinselen der weeghconst.* Leiden 1586 (BRB). See § 13.

Fig. 7. *De weeghdaet.* Leiden 1586 (BRB). See § 13.

Fig. 8. *De beghinselen des waterwichts.* Leiden 1586 (BRB). See § 13.

Fig. 9. *Vita politica. Het burgherlick leven.* Leiden 1590 (BRB). See § 14.

Fig. 10. *De sterctenbovwing.* Leiden 1594 (BRB). See § 16.

Fig. 11. *De havenvinding.* Leiden 1599 (HCO, after HELLMANN). See § 17.

Fig. 12. *The havenfinding art.* London 1599 (HL). See § 17.

Fig. 13. *Wisconstige gedachtenissen.* Leiden 1608 (BRB). See § 18-24.

Fig. 14. *Tweede stuck der wisconstighe ghedachtnissen.* Leiden 1605 (BRB). See § 18-24.

Note that the words "*wisconstige gedachtenissen*" are spelled differently in vol. 1 and vol. 2, and that the dates of these volumes according to the original titlepages are respectively 1608 and 1605. See § 19.

Fig. 15. *Hypomnemata mathematica.* Leiden 1608 (HUL). See § 18-24.

Fig. 16. *Tomus quartus mathematicorum hypomnematum.* Leiden 1605 (HUL). See § 13, 18, 19, 23.

Fig. 17. *Mémoires mathématiques.* Leiden 1608 (HUL). See § 18-19.

Fig. 18. *Livre de compte de prince à la manière d'Italie.* Leiden 1608 (BRB). See § 25.

Fig. 19. *Castrametatio, dat is legermeting.* Rotterdam 1617 (BRB). See § 26.

Fig. 20. *Nievwe maniere van sterctebov door spilsluysen.* Rotterdam 1617 (LUG). See § 26.

Fig. 21. *La castrametation.* Leiden 1618 (HUL). See § 26.

Fig. 22. *Les œuvres mathématiques de* S. STEVIN, edited by ALBERT GIRARD. Leiden 1634 (HUL). See § 27.

Fig. 23. *Materiae politicae. Burgherlicke stoffen,* edited by H. STEVIN. Leiden (1649) (BRB). See § 28.

Fig. 24. HENDRIC STEVIN: *Wisconstich filosofisch bedrijf.* Leiden 1667 (LUG). See § 29.

Fig. 25. *Les Artificiels chariots à voiles du comte* MAURICE. Amsterdam 1652 (BM). See § 59.

Fig. 26. *Comitis* MAURITII *Currus artificiales vento acti.* Amsterdam 1652 (BM). See § 59.

Plate 3. Fig. 27. Engraving by JACQUES DE GHEYN (?) Amsterdam 1652, representing STEVIN's sailing chariots (BM). The original engraving (without borders) measures 32.3 × 25.1 cm. See § 59.

Plate 4. Fig. 28. Engraving showing chassis of STEVIN's sailing chariot. Amsterdam 1652 (BM). Probably derived from the woodcut by C. v. SICHEM, published in Amsterdam 1612. See F. MULLER : *De Nederlandsche geschiedenis in platen* (vol. 1, 141, 1863-70).

Fig. 29. Equilibrium of ships. Figure taken from *Tomus quartus mathematicorum hypomnematum.* Leiden 1605, p. 179 (HUL). See § 23, 52.

Fig. 30. Lock. Figure taken from the *Nouvelle manière de fortifications par escluses.* Leiden 1618, p. 4 (HUL). See § 26, 57.

V. — APPENDIX

63*bis*. Reproduction in extenso of the text published in Amsterdam, 1652. See § 59 and figs. 25 to 28.

Les Artificiels Chariots à Voiles du comte Maurice.

Lesquels Chariots en 2 heures ont faict 14 lieuës de chemin : Sur ces chariots estoyent les Nobles du pays d'Hollande & quelques grands Seigneurs de Pays estranges, ensemble jusques au nombre de 28 personnes, comme la description suivante declare plus amplement.

Personne ne sera esmerveillé si je raconte comment les Hollandois ont faict par mer des lointains voyages aux pays mesme inconnus aux anciens escrivains, mais si je commence à dire qu'ils ont fait voyle sur terre avec un Chariot à voyle, tout le monde ne sera pas seulement esbahy, mais plusieurs (qui ne croyent rien que ce qu'ils voyent) ne le croyront pas. Mais l'incredulité des ignorans ne diminuë en rien les faicts ingenieux des sçavans, ainsi au contraire les font tant plus estimer de personnes de gentil esprit : ausquels j'adresse ce Chariot avec sa description touchee en peu de parolles pour laisser aux doctes ample matiere de le descrire. Ie descri le Chariot ou estoyt son Excellence.

Quant au Chariot & sa figure, n'attendés que je le vous d'escrive : le paintre, Mr. JAQUES DE GHEYN, a tellement satis-fait a cela, que ce seroit paindre Venus apres Apelle de le vouloir d'escrire. Il me suffira de vous raconter le voyage que ce Chariot a faict, & de nommer les principaux personnages qui nestoyent assis en iceluy.

Il y a une place aupres de la Haye, là estoit ce ou le Chariot a voyle fut tout prest sur la rive de la mer, attendant avec un ven de sudest la venue du tant renommé MAURICE DE NASSAU, lequel y vint avec quelques grands personnages, a scauoir le frere du Roy de Dennemarcq, le Comte HENRY, frere du Comte

de Nassau, avec quelques autres Seigneurs Alemands. Pardonnez moy si je ne mets au premier rang le Seigneur de BUSENVAL, Ambassadeur vers les Estats d'Hollande, de la part du Treschrestien Roy de France : nous escrivons cecy en Hollande, où son Excellence tient le premier rang. Or sans me mesler de Precedence (en laquelle je n'ay jamais estudié) je poursuyvray le reste. Là estoyt oultre quelques Seigneurs Angloys, l'Admirante d'Arragon : en quoy on peut voir combien civilement on traicte chez nous les prisonniers. Avec un mot vingt huict Personnes estoyent sur le chariot à voyle.

Ils ont choysi un vent de Sudest, & son montés a la rive de la mer; nommée de Sy, comme estant le costé du pays ou la mer nous separe du royaume d'Angleterre : là est le village Schevelingne sus mentionné, environ une lievë de le Haye, Court d'Hollande. Estant montés, son Excellence s'est mis au gouvernail : on a faict voyle. Voyla le vent qui pousse tellement ce Chariot, qu'il ne sembloyt pas rouler, ains voler, en sorte qu'on l'avoit si tost perdu, que veu.

Ils est tout subit venu devant l'ancien Village Catwijck, monstant nostre origine estre des Hessiens, nommés des anciens Catti : là est l'Ancien Chasteau submergé de la mer qu'on appelle la Tour de Capus : les Hollandois l'appellent het Huys te Britten.

De là il est venu a Noortwijck, ou son nès deux grands Poëtes renommés entre les doctes avec le nom de Dousa. Subit il passe Santvoort, Wijck, Egmont, renommé par son Comte. Enfin il est venu à la place nommée le Hondbosch : ou la mer faict tel esmoy, qu'il semble la Scylle des anciens, croule sur les cailloux & menace Hollande de submersion : là les mariniers sont en crainte de Naufrage : Si ceste place n'estoyt pas bien pourveus Hollande ne seroit point Land (C'est ádire Pays) mais une mer. Là est le Village de Petten, où on trouve des petites moules fort delicats. Bien pres de lá est la Sype, comme un Pays ravi à la mer, & gardé avec diques. La aupres est Marsdiep, Vli, & autres places. Le Chariot a fini son cours à Petten susnommé.

Or tout le chemin susdit se monte à quatorse lieuës, lequel ceste navire sur terre (ainsi je nomme le Chariot) fict en deux heures. Il ne sembloyt pas (comme j'ay dit) rouler, ains voler : & je ne scay si quelque oyseau volant apres sa proye pouvoit aller plus viste.

Les chevaux courrants apres le Chariot, ne gaignoyent rien en courant à poste, le postillon du vent poussoit tellement ce Chariot, qu'il passoit l'œil humain. Une foys, pour faire jeu aux Seigneurs, son Excellence le faisoit rouler dans la mer, dont plusieurs estoyent fort estonnés, mais subit tournant le gouvernail, il print son cours sur la rive, & fit en deux heures le chemin susdict.

Les spectateurs, qui estoyent sur la rive, mais principalement ceux qui l'ont veu à la despourveuë, ne croyoyent a leur yeux, tant viste rouloit ce Chariot, en sorte que le cours de ma plume ne le peut suyvre.

Une infinitè de personnes tesmoignera tout cecy que j'ay racontè brievement de son voyage. Ne soyés donc plus lecteur, ains Spectateur : vojez le pourtraict que le paintre vous donne avec son burin, & vojez si vous pouvès imiter tel Artifice. Adieu amy Lecteur & Spectateur, prennez en grè ce que nous vous offrons d'aussi bonne affection, comme nous souhaitons qu'il soit reçeu de vous.

Harvard Library 185 GEORGE SARTON.
Cambridge, Mass.

Tafelen van

INTEREST,

Midtſgaders

De Conſtructie der ſel-
uer, ghecalculeert

DOOR

Simon Stevin Brugghelinck.

T'ANTWERPEN,
By Chriſtoffel Plantijn in den
gulden Paſſer.

M. D. LXXXII.

Fig. 3

PROBLEMATVM
GEOMETRICORVM

In gratiam D. MAXIMILIANI, DOMINI A CRVNINGEN &c. editorum, Libri V.

Auctore

SIMONE STEVINIO BRVGENSE.

ANTVERPIAE,
Apud Ioannem Bellerum ad inſigne
Aquilæ aureæ.

Fig. 4

DIALECTIKE
OFTE
BEVVYSCONST.

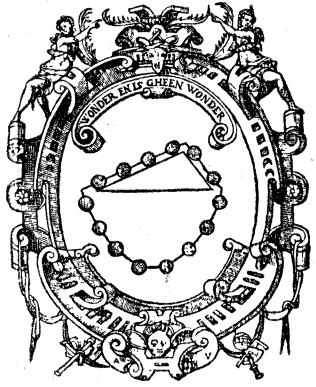
Leerende van allen ſaecken recht ende conſtelick Oirdeelen; Oock openende den wech tot de alderdiepſte verborghentheden der Natueren.

Beſchreven int Neerduytſch door
SIMON STEVIN *van Brugghe.*

TOT LEYDEN,
By Chriſtoffel Plantijn.
M. D. LXXXV.

Fig. 5

DE
BEGHINSELEN
DER WEEGHCONST
BESCHREVEN DVER
SIMON STEVIN
van Brugghe.

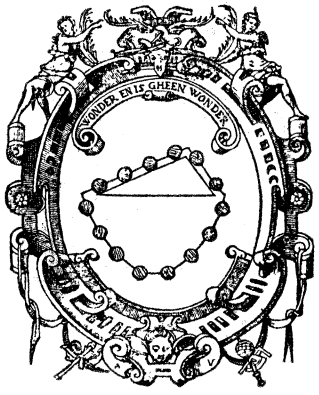


TOT LEYDEN,
Inde Druckerye van Chriſtoffel Plantijn,
By Françoys van Raphelinghen.
cIↃ. IↃ. LXXXVI.

Fig. 6

DE WEEGHDAET

BESCHREVEN DVER
SIMON STEVIN
van Brugghe.

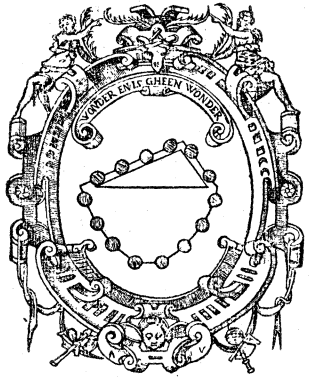


TOT LEYDEN,
Inde Druckerye van Christoffel Plantijn,
By Françoys van Raphelinghen.
cIↃ. IↃ. LXXXVI.

Fig. 7

DE BEGHINSELEN DES WATERWICHTS

BESCHREVEN DVER
SIMON STEVIN
van Brugghe.



TOT LEYDEN,
Inde Druckerye van Christoffel Plantijn,
By Françoys van Raphelinghen.
cIↃ. IↃ. LXXXVI.

Fig. 8

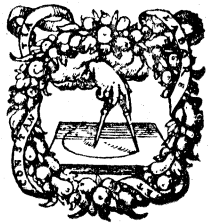
VITA POLITICA.

HET

Burgherlick leuen,

Beſchreuen deur

SIMON STEVIN.



TOT LEYDEN,

By Franchoys van Ravelenghien.

clɔ. Iɔ. xc.

Fig. 9

DE

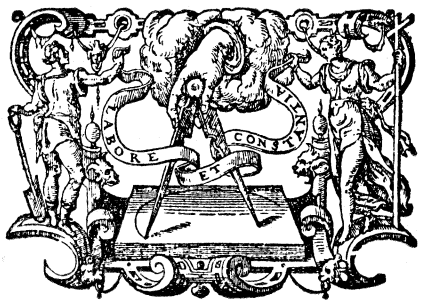
STERCTENBOVWING,

Beſchreuen

door

SIMON STEVIN

van Brugghe.



TOT LEYDEN,

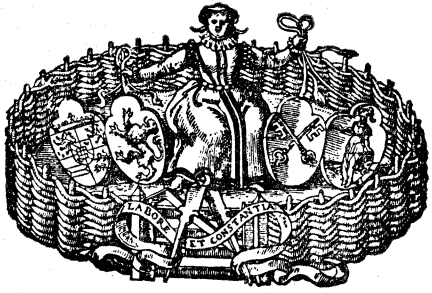
By Françoys van Ravelenghien.

clɔ. Iɔ. xciv.

Fig. 10

DE

HAVEN-VINDING.



TOT LEYDEN,
IN DE DRVCKERYE VAN PLANTIIN
BY CHRISTOFFEL VAN RAVELENGHIEN.
Gesworen drucker der Vniuersiteyt tot Leyden.
cIↃ. IↃ. IC.

Met priuilegie.

Fig. 11

THE HAVEN-FINDING ART,

Or

THE WAY TO FIND any Hauen or place at sea, by *the Latitude and variation.*

Lately published in the Dutch, French, and Latine tongues, by commandement of the right honourable *Count Mauritz* of *Nassau*, Lord high Admiral of the vnited Prouinces of the Low countries, enioyning all Seamen that take charge of ships vnder his iurisdiction, to make diligent obseruation, in all their voyages, according to the directions prescribed herein:

And now translated into English, for the common benefite of the Seamen of England,

Imprinted at London by *G.B.R.N.* and *R.B.*

1599.

Fig. 12

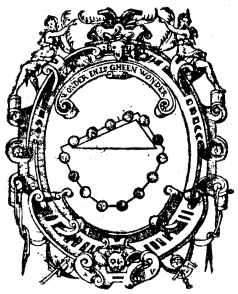
WISCONSTIGE GEDACHTENISSEN,

Inhoudende t'ghene daer hem in gheoeffent heeft

DEN DOORLVCHTICHSTEN

Hoochgheboren Vorst ende Heere, MAVRITS Prince van Oraengien, Gravé van Nassau, Catzenellenbogen, Vianden, Moers &c. Marckgraef vander Vere, ende Vlissinghen &c. Heere der Stadt Grave ende S'landts van Cuyc, S'. Vyt, Daesburch &c. Gouverneur van Gelderlant, Hollant, Zeelant, Westvrieslant, Zutphen Vtrecht, Overyssel &c. Opperste Veltheer vande vereenichde Nederlanden, Admirael generael vander Zee &c.

Beschreven deur SIMON STEVIN *van Brugghe.*



TOT LEYDEN,
Inde Druckerye van Ian Bouvvensz.
Int Iaer clɔ Iɔ cvIII.

Fig. 13

T VV EEDE STVCK DER WISCONSTIGHE GHEDACHTNISSEN VANDE MEETDAET.

De practi Geometrie

Inhoudende t'ghene daer hem in gheoeffent heeft

DEN DOORLVCHTICHSTEN

Hoochgheboren Vorst ende Heere MAVRITS Prince van Oraengien, Grave van Nassau, Catzenellenbogen, Vianden, Moers &c. Marckgraef vander Vere, ende Vlissinghen &c. Heere der Stadt Grave, ende S'landts van Cuyc, S'. Vyt, Daesburch &c. Gouverneur van Gelderlant, Hollant, Zeelant, Westvrieslant, Zutphen, Vtrecht, Overyssel &c. Opperste Veltheer vande vereenichde Nederlanden, Admirael Generael vander Zee &c.

Beschreven deur SIMON STEVIN *van Brugghe.*

TOT LEYDEN,
By Ian Bouvvensz. woonende op de hoogelantsche Kerckgraft,
Anno clɔ Iɔ cv.

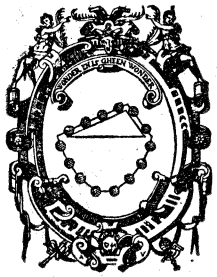
Fig. 14

HYPOMNEMATA
MATHEMATICA.

Hoc eſt eruditus ille pulvis, in quo ſe exercuit

ILLVSTRISSIMVS, ILLVSTRIS-
ſimo & antiquiſſimo ſtemmate ortus Princeps, ac Dominus,
MAURITIUS Princeps Auraïcus, Comes Naſſoviæ, Catzimo-
libocorum, Viandæ, Moerſii, &c. Marchio Veræ, & Vliſſingæ, &c. Dominus
civitatis Gravæ, & ditionis Cuyc, civitatum Vyt, Daesburch, &c.
Gubernator Geldriæ, Hollandiæ, Zelandiæ, Weſtfriſiæ,
Zutphaniæ, Vltrajecti, Tranſiſalanæ, &c. Imperator
exercitus Provinciarum fœdere conſocia-
tarum Belgii, Archithalaſſus
Generalis, &c.

A SIMONE STEVINO *conſcripta, & à Beldeckio*
Latinum à VVIL. SN. *converſa.*



LVGDVNI BATAVORVM,
Ex Officinâ Ioannis Patii, Academiæ Typographi.
Anno clɔ. lɔ. c, VIII.

Fig. 15

TOMVS QVARTVS
MATHEMATICORVM HYPOMNEMATVM DE
STATICA.

Quo comprehenduntur ea in quibus ſeſe exercuit

ILLVSTRISSIMVS
Illuſtriſsimo & antiquiſsimo ſtemmate ortus Princeps ac
Dominus MAURITIUS Princeps Auraicus, Comes
Naſſoviæ, Catti-melibocorum, Viandæ, Moerſii, &c. Marchio Veræ
& Vliſſingæ, &c. Dominus Civitatis Gravæ & ditionis Cuyc,
Civitatum Vyt, Daesburch, &c. Gubernator Geldriæ,
Hollandiæ, Zelandiæ, Weſtfriſiæ, Zutphaniæ,
Vltrajecti, Tranſiſalanæ, &c. Imperator exer-
citus Provinciarum fœdere conſociata-
rum Belgii, Archithalaſſus
Generalis, &c.

Conſcriptus à SIMONE STEVINO *Brugenſi.*

LVGODINI BATAVORVM,
Ex Officinâ Ioannis Patii, Academiæ Typographi.
Anno clɔ lɔ cv.

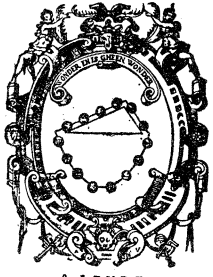
Fig. 16

MEMOIRES MATHEMATIQVES.

Contenant ce en quoy s'eſt exercé

LE TRES-ILLVSTRE, TRES-excellent Prince & Seigneur MAVRICE Prince d'Orange, Comte de Naſſau, Catzenellenboghen, Vianden, Moers, &c. Marquis de la Vere, & Vliſſingues, &c. Seigneur de la Ville de Grave, & du Païs de Cuyck, Sainct Vyt, Daesburch, &c. Gouverneur de Gueldres, Hollande, Zeelande, Weſtfriſe, Zutphen, Vtrecht, Overyſſel, &c. Chef General de l'armée des Provinces unies du Païs bas, Admiral general de la Mer, &c.

Deſcrit premierement en Bas Allemand par SIMON STEVIN *de Bruges, translaté en François par* IEAN TVRNE, *Licencié és Loix, & Secretaire de Monſeigneur le* PRINCE HENRY, *Comte de Naſſau, &c.*



A LEYDE,
Chez Ian Paedts Iacobsz. Marchand Libraire,
& Maiſtre Imprimeur de l'Vniverſité de ladite Ville.
L'An cIↃ. IↃ. c. VIII.

Fig. 17

LIVRE DE COMPTE DE PRINCE A LA MANIERE D'ITALIE,

EN DOMAINE ET FINANCE EXTRAORDINAIRE,

Eſtant aux memoires Mathematiques la deuxieſme partie des meſlanges,

Contenant ce en quoy s'eſt exercé

LE TRES-ILLVSTRE, TRES-EXcellent Prince & Seigneur MAVRICE Prince d'Orange, Comte de Naſſau, Catzenellenboghen, Vianden, Moers, &c. Marquis de la Vere, & Vliſſingues &c. Seigneur de la Ville de Grave, & du Païs de Cuyck, Sainct Vyt, Daesburch &c. Gouverneur de Gueldres, Hollande, Zeelande, Weſtfriſe, Zutphen, Vtrecht, Overyſſel &c. Chef General de l'armée des Provinces unies du Païs bas, Admiral general de la Mer &c.

Deſcrit par SIMON STEVIN *de Bruges.*

A LEYDE,
Chez Ian Paedts Iacobsz. Marchand Libraire,
& Maiſtre Imprimeur de l'Vniverſité de ladite Ville.
L'An cIↃ IↃ cVIII.

On les trouve à vendre chés Louys Elzevier.

Fig. 18

CASTRAMETATIO,

Dat is

LEGERMETING.

Beſchreven door *Symon Stevin* van Brugghe,

Na d'oordening en 'tghebruyc

VANDEN DOORLVCHTICHSTEN

Hoochgheboren Vorſt ende Heere MAVRITS PRINCE van Oraengien, Grave van Naſſau, Catzenellenboghen, Vianden, Moers, &c. Marcgraef vanden Vere, ende Vliſſinghen, &c. Heere der Stadt Grave, ende 'sLandts van Cuyc, S. Vyt, Daesborch, &c. Gouverneur van Ghelderlant, Hollant, Zeelant, Weſtvrieſlant, Vtrecht, Overyſſel, &c. Opperſte Veltheer vande verenichde Nederlanden, Admirael generael vanden Zee, &c.

TOT ROTTERD'AM,

By Ian van VVaesberghe, inde Fame.

ANNO 1617.

Fig. 19

NIEVVE MANIERE

VAN

STERCTEBOV,

door Spilſluyſen.

Beſchreven door *Symon Stevin* van Brugghe.

TOT ROTTERDAM,

By Ian van VVaesberghe, inde Fame.

ANNO 1617.

Fig. 20

LA

CASTRAME-TATION,

Descrite par *Symon Stevin* de Bruges,
selon l'ordonnance & vsage
DE

TRESILLVSTRE, TRES EXCELLENT PRINCE ET

Seigneur MAVRICE, par la grace Dieu PRINCE d'Orangé, COVNTE de Nassau, Catzenellenbogen, Vianden, Diets, Moers, Bure, Leerdam, Marquis de la Vere, & de Flissingues, Seigneur & Baron de Breda, de la Ville de Grave, & du Païs de Cuyck, Diest, Grimbergues, Arlay, Nosteroy, &c. Vicomte Hereditaire d'Anvers, & Besançon, Gouverneur & Capitaine Genéral de Gueldres, Hollande, Zelande, Westfrise, Zutphen, Vtrecht, & Overyssel, &c. Admiral General, &c.

A LEYDEN,
Chez Matthieu & Bonaventure Elzevier. 1618.

Fig. 21

LES

ŒUVRES Mathematiques

DE

SIMON STEVIN de Bruges.

Ou sont inserées les

MEMOIRES MATHEMATIQVES,

Esquelles s'est exercé le Tres-haut & Tres-illustre Prince MAURICE de NASSAU, Prince d'Aurenge, Gouverneur des Provinces des Pais bas unis, General par Mer & par Terre, &c.

Le tout reveu, corrigé, & augmenté

Par ALBERT GIRARD Samielois, Mathematicien.

A LEYDE
Chez Bonaventure & Abraham Elsevier, Imprimeurs ordinaires de l'Université, ANNO CIↃ IↃ CXXXIV.

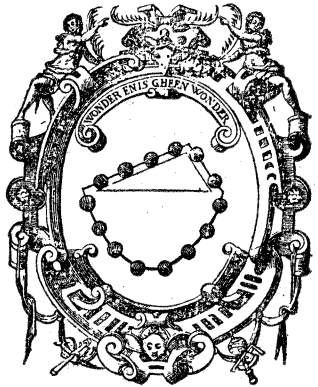
Fig. 22

MATERIÆ POLITICÆ.

BVRGHERLICKE STOFFEN.

VERVANGHENDÆ GHEDACHTENISSEN der oeffeninghen des Doorluchtichſten Hoogſtgheboorens *Vorſt en Heere* MAVRITS *by Gods Genade Prince van Orangie &c. Ho: Lo: Ghedachtenſſe.*

Beſchreven deur zal: SIMON STEVIN van Brugghe, des ſelfs Heere Princen Superintendent vande Finance &c. En uyt ſijn naghelate Hantſchriften by een ghelleſt deur Sijn Soon HENDRICK STEVIN Anbachtighertje van Alphen.



TOT LEYDEN,
Ter Druckerye van IVSTVS LIVIVS,
tegen over d'Academie.

Fig. 23

WISCONSTICH FILOSOFISCH BEDRYF,

Van *Hendric Stevin* Heer van Alphen,
van Schrevelsrecht, &c.

BEGREPEN
In veertien Boeken.

TOT LEYDEN,
Gedruckt by PHILIPS DE CRO-Y, in't Jaer 1667.

Fig. 24

Les Artificiels
CHARIOTS A VOILES
du Comte Maurice.

Leſquels Chariots en 2 heures ont faict 14 lieuës de chemin : Sur ces chariots eſtoyent des Nobles du pays d'Hollande & quelques grands Seigneurs de Pays eſtranges, enſemble juſques au nombre de 28 perſonnes, comme la deſcription ſuivante declare plus amplement.

PErſonne ne ſera eſmerveillé ſi je raconte comment les Hollandois ont faict par mer des lointains voyages aux pays meſme inconnus aux anciens eſcrivains, mais ſi je commence à dire qu'ils ont fait voyle ſur terre avec un Chariot à voyle, tout le monde ne ſera pas ſeulement esbahy, mais pluſieurs (qui ne croyent rien que ce qu'ils voyent) ne le croyront pas. Mais l'incredulité des ignorans ne diminuë en rien les faicts ingenieux des ſçavans, ains au contraire les font tant plus eſtimer de perſonnes de gentil eſprit : auſquels j'adreſſe ce Chariot avec ſa deſcription touchee en peu de parolles pour laiſſer aux doctes ample matiere de le deſcrire. Ie deſcri le Chariot ou eſtoyt ſon Excellence.

Quant au Chariot & ſa figure, n'attendés que je le vous d'eſcrive: le painre, Mr. Jaques de Gheyn, a tellement ſatis-fait a cela, que ce ſeroit paindre

Fig. 25

Comitis Mauritii
CURRUS ARTIFICIALES
Vento acti.

Hi currus duarum horarum ſpatio quatuordecim itineris milliaria perfecerunt, iiſque Nobiles Hollandiæ unà cum Magnatibus alienigenis quibuſdam, numero 28, vecti quondam fuere, ut ſequens deſcriptio latius manifeſtat.

NEmo mirabitur, ſi enarrem Hollandos diuturnis navigationibus per mare in regiones etiam antiquis ſcriptoribus incognitas fuiſſe peregrinatos ; Statim verò ac dixero eos currui a vento acto in ipsâ terrâ vela feciſſe, univerſus terrarum orbis non ſolum admirabundus obſtupeſcet, ſed multi (qui nihil credunt niſi quod vident) fidem non adhibebunt. Verum ignorantium incredulitas actibus illis, in quibus ingenii humani acies elucet, nihil prorſus ſubtrahit, quin potius illos viris cordatis tanto magis commendat, quibus equidem hunc currum, cum tota deſcriptione paucis perſtrictâ, offerendum putavi, eoque doctis ampliorem illum deſcribendi materiam præbui. Currum autem quem deſcribo ille eſt, quo ſua Excellentia vehebatur. Quantum ad Currus iſtius figuram attinet, me illum vobis depingere nullatenus expectate. Pictor Magiſter Jacobus de Gheim huic rei adeo imparem fecit, ut qui poſt illum id tentare conaretur, Venerem ab Apelle pictam pingere velle videretur. Iter ab illo curru confectum vobis enarrare, & præcipuos qui in illo curru ſedebant recenſere, mihi ſatis erit. Locus eſt prope Hagam Comitis, ubi erat currus veliſer juxta littus maris præparatus, & expectans cum vento meridionali adventum Illuſtriſſimi viri Mauritii à Naſſau. Qui utique illuc venit cum Magnatibus nonnullis, videlicet fratre Regis Daniæ, Comite Henrico, fratre Comitis à Naſſau, cum quibuſdam aliis Nobilibus Germanis. Date mihi veniam ſi non primo loco colloco dominum à Buſenval, Chriſtianiſſimi Galliæ Regis apud præpotentes Hollandiæ ordines Legatum : Hæc enim in Hollandia ſcribimus, ubi ſua Excellentia primum locum obtinet. Omiſſis autem quæ ad præeminentias ſpectant (quibus nunquam ſtudui)

Fig. 26

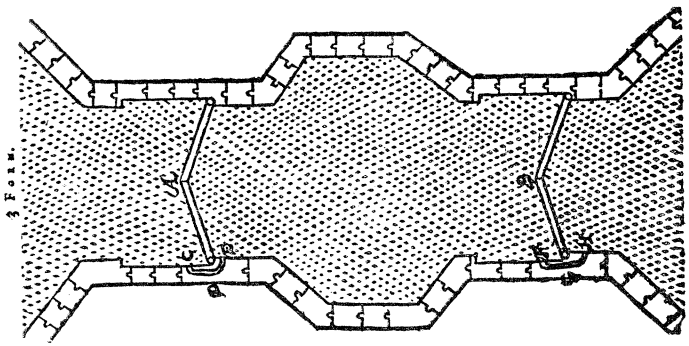


Fig. 30
Lock.

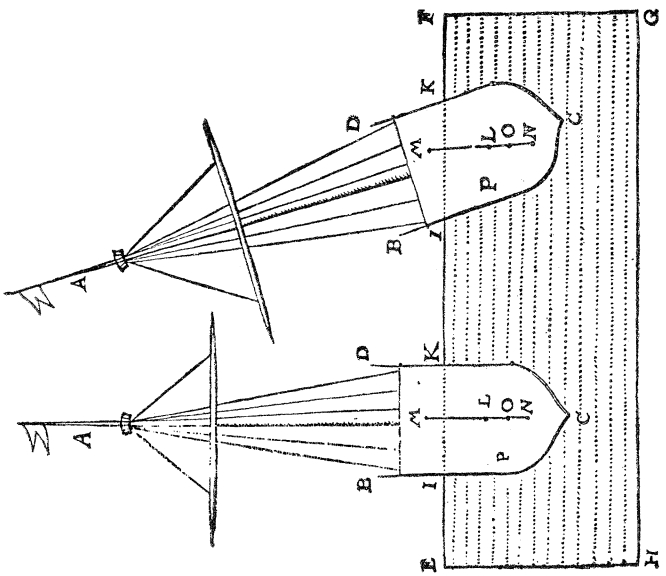


Fig. 29
Equilibrium of ships.