CAJORI FLORIAN

ON THE HISTORY OF GUNTER'S SCALE AND THE SLIDE RULE DURING THE SEVENTEENTH CENTURY

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Cajori F.

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Содержание

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I. INTRODUCTION

In my history of the slide rule[1], and my article on its invention[2] it is shewn that William Oughtred and not Edmund Wingate is the inventor, that Oughtred's circular rule was described in print in 1632, his rectilinear rule in 1633. Richard Delamain is referred to as having tried to appropriate the invention to himself[3] and as having written a scurrilous pamphlet against Oughtred. All our information about Delamain was taken from De Morgan,[4] who, however, gives no evidence of having read any of Delamain's writings on the slide rule. Through Dr. Arthur Hutchinson of Pembroke College, Cambridge, I learned that Delamain's writings on the slide rule were available. In this article will be given: First, some details of the changes introduced during the seventeenth century in the design of Gunter's scale by Edmund Wingate, Milbourn, Thomas Brown, John Brown and William Leybourn; second, an account of Delamain's book of 1630 on the slide rule which antedates Oughtred's first *publication* (though Oughtred's date of *invention* is earlier than the date of Delamain's alleged invention) and of Delamain's later designs of slide rules; third, an account of the controversy between Delamain and Oughtred; fourth, an account of a later book on the slide rule written by William Oughtred, and of other seventeenth century books on the slide rule.

[1] F. Cajori, *History of the Logarithmic Slide Rule and Allied Instruments*, New York, 1909, pp. 7-14, also Addenda i-vi.

[2] F. Cajori, "On the Invention of the Slide Rule," in *Colorado College Publication*, Engineering Series Vol. 1, 1910. An abstract of this is given in *Nature* (London), Vol. 82, 1909, p. 267.

[3] F. Cajori, *History* etc., p. 14.

[4] Art. "Slide Rule" in the *Penny Cyclopaedia* and in the *English Cyclopaedia* [Arts and Sciences].

II. INNOVATIONS IN GUNTER'S SCALE

Changes introduced by Wingate

We begin with Anthony Wood's account of Wingate's introduction of Gunter's scale into France.[5]

> In 1624 he transported into France the rule of proportion, having a little before been invented by Edm. Gunter of Gresham Coll. and communicated it to most of the chiefest mathematicians then residing in Paris: who apprehending the great benefit that might accrue thereby, importun'd him to express the use thereof in the French tongue. Which being performed accordingly, he was advised by monsieur Alleawne the King's chief engineer to dedicate his book to monsieur the King's only brother, since duke of Orleans. Nevertheless the said work coming forth as an abortive (the publishing thereof being somewhat hastened, by reason an advocate of Dijon in Burgundy began to print some uses thereof, which Wingate had in a friendly way communicated to him) especially in regard Gunter himself had learnedly explained its use in a far larger volume.[6]

Gunter's scale, which Wingate calls the "rule of proportion," contained, as described in the French edition of 1624, four lines: (1) A single line of numbers; (2) a line of tangents; (3) a line of sines; (4) a line, one foot in length, divided into 12 inches and tenths of inches, also a line, one foot in length, divided into tenths and hundredths.

The English editions of this book which appeared in 1623 and 1628 are devoid of interest. The editions of 1645 and 1658 contain an important innovation.[7] In the preface the reasons why this instrument has not been used more are stated to be: (1) the difficulty of drawing the lines with exactness, (2) the trouble of working thereupon by reason (sometimes) of too large an extent of the compasses, (3) the fact that the instrument is not readily portable. The drawing of Wingate's arrangement of the scale in the editions of 1645 and 1658 is about 66 cm. (26.5 in.) long. It contains five parallel lines, about 66 cm. long, each having the divisions of one line marked on one side and of another line on the other side. Thus each line carries two graduations: (1) A single logarithmic line of numbers; (2) a logarithmic line of numbers thrice repeated; (3) the first scale repeated, but beginning with the graduations which are near the middle of the first scale, so that its graduation reads 4, 5, 6, 7, 8, 9, 1, 2, 3; (4) a logarithmic line of numbers twice repeated; (5) a logarithmic line of tangents; (6) a logarithmic line of sines; (7) the rule divided into 1000 equal parts; (8) the scale of latitudes; (9) a line of inches and tenths of inches; (10) a scale consisting of three kinds, viz., a gauge line, a line of chords, and a foot measure, divided into 1000 equal parts.

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[5] Anthony Wood, *Athenae oxonienses* (Ed. P. Bliss), London, Vol. III, 1817, p. 423.

[6] The full title of the book which Wingate published on this subject in Paris is as follows:L'Vsage | de la | Reigle de | Proportion | en l'Arithmetique & | Geometrie. | Par Edmond Vvingate, | Gentil-homme Anglois. |Εἀν ἦς φιλεμαθὴς, ἔση ἥση πολυμαθὴς.In tenui, sed nõ tenuis vsusve, laborne. |A Paris, | Chez Melchior Mondiere, | demeurant en l'Isle du Palais, | à la | ruë de Harlay aux deux Viperes. | M. DC. XXIV. | Auec Priuilege du Roy. |Back of the title page is the announcement:Notez que la Reigle de Proportion en toutes façons se vend à Paris chez Melchior Tauernier, Graueur & Imprimeur du Roy pour les Tailles douces, demeurant en l'Isle du Palais sur le Quay qui regarde la Megisserie à l'Espic d'or.

[7] The title-page of the edition of 1658 is as follows:The Use of the Rule of Proportion in Arithmetick & Geometrie. First published at Paris in the French tongue, and dedicated to Monsieur, the then king's onely Brother (now Duke of Orleance). By Edm. Wingate, an English Gent. And now translated into English by the Author. Whereinto is now also inserted the Construction of the same Rule, & a farther use thereof.. 2nd edition inlarged and amended. London, 1658.

Important are the first and second scales, by which cube root extraction was possible "by inspection only, without the aid of pen or compass;" similarly the third and fourth scales, for square roots. This innovation is due to Wingate. The 1645 edition announces that the instrument was made in brass by Elias Allen, and in wood by John Thompson and Anthony Thompson in Hosier Lane.

Changes introduced by Milbourn

William Leybourn, in his *The Line of Proportion or Numbers, Commonly called Gunter's Line, Made Easie*, London, 1673, says in his preface "To the Reader:"

> The Line of Proportion or Numbers, commonly called (by Artificers) Gunter's Line, hath been discoursed of by several persons, and variously applied to divers uses; for when Mr. Gunter had brought it from the Tables to a Line, and written some Uses thereof, Mr. Wingate added divers Lines of several lengths, thereby to extract the Square or Cube Roots, without doubling or trebling the distance of the Compasses: After him Mr. Milbourn, a Yorkshire Gentleman, disposed it in a Serpentine or Spiral Line, thereby enlarging the divisions of the Line.

On pages 127 and 128 Leybourn adds:

> Again, One T. Browne, a Maker of Mathematical Instruments, made it in a Serpentine or Spiral Line, composed of divers Concentrick Circles, thereby to enlarg the divisions, which was the contrivance of one Mr. Milburn a Yorkshire Gentleman, who writ thereof, and communicated his Uses to the aforesaid Brown, who (since his death) attributed it to himself: But whoever was the contriver of it, it is not without inconvenience; for it can in no wise be made portable; and besides (instead of compasses) an opening Joynt with thirds [threads] must be placed to move upon the Centre of the Instrument, without which no proportion can be wrought.

This Mr. Milburn is probably the person named in the diary of the antiquarian, Elias Ashmole, on August 13 [1646?]; "I bought of Mr. Milbourn all his Books and Mathematical Instruments."[8] Charles Hutton[9] says that Milburne of Yorkshire designed the spiral form about 1650. This date is doubtless wrong, for Thomas Browne who, according to Leybourn, got the spiral form of line from Milbourn, is repeatedly mentioned by William Oughtred in his *Epistle*[10] printed some time in 1632 or 1633. Oughtred does not mention Milbourn, and says (page 4) that the spiral form "was first hit upon by one Thomas Browne a Joyner… the serpentine revolution being but two true semicircles described on severall centers."[11]

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[8] *Memories of the Life of that Learned Antiquary, Elias Ashmole, Esq.; Drawn up by himself by way of Diary. With Appendix of original Letters.* Publish'd by Charles Burman, Esq., London, 1717, p. 23.

[9] *Mathematical Tables*, 1811, p. 36, and art. "Gunter's Line" in his *Phil. and Math. Dictionary*, London, 1815.

[10] *To the English Gentrie, and all others studious of the Mathematicks, which shall bee readers hereof. The just Apologie of Wil: Ovghtred, against the slaunderous insimulations of Richard Delamain, in a Pamphlet called Grammelogia, or the Mathematicall Ring, or Mirifica logarithmorum projectio circularis.* We shall refer to this document as *Epistle*. It was published without date in 32 unnumbered pages of fine print, and was bound in with Oughtred's *Circles of Proportion*, in the editions of 1633 and 1639. In the 1633 edition it is inserted at the end of the volume just after the *Addition vnto the Vse of the Instrument etc.*, and in that of 1639 immediately after the preface. It was omitted from the Oxford edition of 1660. The *Epistle* was also published separately. There is a separate copy in the British Museum, London. Aubrey, in his *Brief Lives*, edited by A. Clark, Vol. II, Oxford, 1898, p. 113, says quaintly, "He writt a stitch't pamphlet about 163(?4) against.. Delamaine."

[11] Thomas Browne is mentioned by Stone in his *Mathematical Instruments*, London 1723, p. 16. See also Cajori, *History of the Slide Rule*, New York, 1909, p. 15.

Changes introduced by Thomas Brown and John Brown

Thomas Brown did not publish any description of his instrument, but his son, John Brown, published in 1661 a small book,[12] in which he says (preface) that he had done "as Mr. Oughtred with Gunter's Rule, to a sliding and circular form; and as my father Thomas Brown into a Serpentine form; or as Mr. Windgate in his *Rule of Proportion*." He says also that "this brief touch of the Serpentine-line I made bold to assert, to see if I could draw out a performance of that promise, that hath been so long unperformed by the promisers thereof." Accordingly in Chapter XX he gives a description of the serpentine line, "contrived in five (or rather 15) turn." Whether this description, printed in 1661, exactly fits the instrument as it was developed in 1632, we have no means of knowing. John Brown says:

> 1. First next the center is two circles divided one into 60, the other into 100 parts, for the reducing of minutes to 100 parts, and the contrary.
>
> 2. You have in seven turnes two inpricks, and five in divisions, the first Radius of the sines (or Tangents being neer the matter, alike to the first three degrees,) ending at 5 degrees and 44 minutes.
>
> 3. Thirdly, you have in 5 turns the lines of numbers, sines, Tangents, in three margents in divisions, and the line of versed sines in pricks, under the line of Tangents, according to Mr. *Gunter's* cross-staff: the sines and Tangents beginning at 5 degrees, and 44 minutes where the other ended, and proceeding to 90 in the sines, and 45 in the Tangents. And the line of numbers beginning at 10, and proceeding to 100, being one entire Radius, and graduated into as many divisions as the largeness of the instrument will admit, being 10 to 10 50 into 50 parts, and from 50 to 100 into 20 parts in one unit of increase, but the Tangents are divided into single minutes from the beginning to the end, both in the first, second and third Radiusses, and the sines into minutes; also from 30 minutes to 40 degrees, and from 40 to 60, into every two minutes, and from 60 to 80 in every 5th minute, and from 80 to 85 every 10th, and the rest as many as can be well discovered.
>
> The versed sines are set after the manner of Mr. *Gunter's* Cross-staff, and divided into every 10th minutes beginning at 0, and proceeding to 156 going backwards under the line of Tangents.
>
> 4. Fourthly, beyond the Tangent of 45 in one single line, for one Turn is the secants to 51 degrees, being nothing else but the sines reitterated beyond 90.
>
> 5. Fifthly, you have the line of Tangents beyond 45, in 5 turnes to 85 degrees, whereby all trouble of backward working is avoided.
>
> 6. Sixthly, you have in one circle the 180 degrees of a Semicircle, and also a line of natural sines, for finding of differences in sines, for finding hour and Azimuth.
>
> 7. Seventhly, next the verge or outermost edge is a line of equal parts to get the Logarithm of any number, or the Logarithm sine and Tangent of any ark or angle to four figures besides the carracteristick.
>
> 8. Eightly and lastly, in the space place between the ending of the middle five turnes, and one half of the circle are three prickt lines fitted for reduction. The uppermost being for shillings, pence and farthings. The next for pounds, and ounces, and quarters of small *Averdupoies* weight. The last for pounds, shillings and pence,

[12] *The Description and Use of a Joynt-Rule:.. also the use of Mr. White's Rule for measuring of Board and Timber, round and square; With the manner of Vsing the Serpentine-line of Numbers, Sines, Tangents, and Versed Sines.* By J. Brown, Philom., London, 1661.

and to be used thus: If you would reduce 16s. 3d. 2q. to a decimal fraction, lay the hair or edge of one of the legs of the index on 16. 3½ in the line of 1. s. d. and the hair shall cut on the equal parts 81 16; and the contrary, if you have a decimal fraction, and would reduce it to a proper fraction, the like may you do for shillings, and pence, and pounds, and ounces.

The uses of the lines follow

As to the use of these lines, I shall in this place say but little, and that for two reasons. First, because this instrument is so contrived, that the use is sooner learned then any other, I speak as to the manner, and way of using it, because by means of first second and third radiusses, in sines and Tangents, the work is always right on, one way or other, according to the Canon whatsoever it be, in any book that treats of the Logarithms, as *Gunter*, *Wells*, *Oughtred*, *Norwood*, or others, as in *Oughtred* from page 64 to 107.

Secondly, and more especially, because the more accurate, and large handling thereof is more then promised, if not already performed by more abler pens, and a large manuscript thereof by my *Sires* meanes, provided many years ago, though to this day not extant in print; so for his sake I claiming my interest therein, make bold to present you with these few lines, in order to the use of them: And first note,

1. Which soever of the two legs is set to the first term in the question, that I call the first leg always, and the other being set to the second term, I call the second leg.

The exact nature of the contrivance with the "two legs" is not described, but it was probably a flat pair of compasses, attached to the metallic surface on which the serpentine line was drawn. In that case the instrument was a slide rule, rather than a form of Gunter's line. In his publication of 1661, as also in later publications,[13] John Brown devoted more space to Gunter's scales, requiring the use of a separate pair of compasses, than to slide rules.

Changes introduced by William Leybourn

The same remark applies to William Leybourn who, after speaking of Seth Partridge's slide rule, returns to forms of Gunter's scale, saying:[14]

There is yet another way of disposing of this Line of Proportion, by having one Line of the full length of the Ruler, and another Line of the same Radius broken in two parts between 3 and 4; so that in working your Compasses never go off of the Line: This is one of the best contrivances, but here Compasses must be used. These are all the Contrivances that I have hitherto seen of these Lines: That which I here speak of, and will shew how to use, is only two Lines of one and the same Radius, being set upon a plain Ruler of any length (the larger the better) having the beginning of one Line, at the end of the other, the divisions of each Line being set so close together, that if you find any number upon one of the Lines, you may easily see what number stands against it on the other Line. This is all the Variation..

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[13] *A Collection of Centers and Useful Proportions on the Line of Numbers*, by John Brown, 1662(?), 16 pages; *Description and Use of the Triangular Quadrant*, by John Brown, London, 1671; *Wingate's Rule of Proportion in Arithmetick and Geometry: or Gunter's Line. Newly rectified by Mr. Brown and Mr. Atkinson, Teachers of the Mathematicks*, London, 1683; *The Description and Use of the Carpenter's-Rule: Together with the Use of the Line of Numbers commonly call'd Gunter's-Line*, by John Brown, London, 1704.

[14] William Leybourn, *op. cit.*, pp. 129, 130, 132, 133.

> *Example 1. If a Board be 1 Foot 64 parts broad, how much in length of that Board will make a Foot Square?* Look upon one of your Lines (it matters not which) for 1 Foot 64 parts, and right against it on the other Line you shall find 61; and so many parts of a Foot will make a Foot square of that Board.

This contrivance solves the equation $1.64x=1$, yielding centesimal parts of a foot.

James Atkinson[15] speaks of "Gunter's scale" as "usually of Boxwood.. commonly 2 ft. long, 1½ inch broad" and "of two kinds: *long Gunter* or *single Gunter*, and the *sliding Gunter*. It appears that during the seventeenth century (and long after) the Gunter's scale was a rival of the slide rule.

[15] James Atkinson's edition of Andrew Wakely's *The Mariners Compass Rectified*, London, 1694 [Wakely's preface dated 1664, Atkinson's preface, 1693]. Atkinson adds *An Appendix containing Use of Instruments most useful in Navigation*. Our quotation is from this *Appendix*, p. 199.

III. RICHARD DELAMAIN'S GRAMMELOGIA

We begin with a brief statement of the relations between Oughtred and Delamain. At one time Delamain, a teacher of mathematics in London, was assisted by Oughtred in his mathematical studies. In 1630 Delamain published the *Grammelogia*, a pamphlet describing a circular slide rule and its use. In 1631 he published another tract, on the *Horizontall Quadrant*.[16] In 1632 appeared Oughtred's *Circles of Proportion*[17] translated into English from Oughtred's Latin manuscript by another pupil, William Forster, in the preface of which Forster makes the charge (without naming Delamain) that "another.. went about to pre-ocupate" the new invention. This led to verbal disputes and to the publication by Delamain of several additions to the *Grammelogia*, describing further designs of circular slide rules and also stating his side of the bitter controversy, but without giving the name of his antagonist. Oughtred's *Epistle* was published as a reply. Each combatant accuses the other of stealing the invention of the circular slide rule and the horizontal quadrant.

Different editions or impressions

There are at least five different editions, or impressions, of the *Grammelogia* which we designate, for convenience, as follows:

Grammelogia I, 1630. One copy in the Cambridge University Library.[18]

Grammelogia II, I have not seen a copy of this.

Grammelogia III, One copy in the Cambridge University Library.[19]

Grammelogia IV, One copy in the British Museum, another in the Bodleian Library, Oxford.[20]

Grammelogia V, One copy in the British Museum.

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[16] R. Delamain, *The Making, Description, and Use of a small portable Instrument.. called a Horizontall Quadrant*, etc., London, 1631.

[17] Oughtred's description of his circular slide rule of 1632 and his rectilinear slide rule of 1633, as well as a drawing of the circular slide rule, are reproduced in Cajori's *History of the Slide Rule*, Addenda, pp. ii-vi.

[18] The full title of the *Grammelogia I* is as follows:Gramelogia | or, | The Mathematicall Ring. | Shewing (any reasonable Capacity that hath | not Arithmeticke) how to resolve and worke | all ordinary operations of Arithmeticke. | And those which are most difficult with greatest | facilitie: The extraction of Roots, the valuation of | Leases, &c. The measuring of Plaines | and Solids. | With the resolution of Plaine and Spherical | Triangles. | And that onely by an Ocular Inspection, | and a Circular Motion. | Naturae secreta tempus aperit. | London printed by John Haviland, 1630.

[19] *Grammelogia III* is the same as *Grammelogia I*, except for the addition of an appendix, entitled:De la Mains | Appendix | Vpon his | Mathematicall | Ring. Attribuit nullo (praescripto tempore) vitae | vsuram nobis ingeniique Deus. | London, |.. The next line or two of this title-page which probably contained the date of publication, were cut off by the binder in trimming the edges of this and several other pamphlets for binding into one volume.

[20] *Grammelogia IV* has two title pages. The first is *Mirifica Logarithmoru' Projectio Circularis*. There follows a diagram of a circular slide rule, with the inscription within the innermost ring: *Nil Finis, Motvs, Circvlvs vllvs Habet*. The second title page is as follows:Grammelogia | Or, the Mathematicall Ring. | Extracted from the Logarythmes, and projected Circular: Now published in the | inlargement thereof unto any magnitude fit for use: shewing any reason- | able capacity that hath not Arithmeticke how to resolve and worke, | all ordinary operations of Arithmeticke: | And those that are most difficult with greatest facilitie, the extracti- | on of Rootes, the valuation of Leases, &c. the measuring of Plaines and Solids, | with the resolution of Plaine and Spherical Triangles applied to the | Practicall parts of Geometrie, Horologographie, Geographie | Fortification, Navigation, Astronomie, &c. | And that onely by an ocular inspection, and a Circular motion, Invented and first published, by R. Delamain, Teacher, and Student of the Mathematicks. | Naturae secreta tempus aperit. |There is no date. There follows the diagram of a second circular slide rule, with the inscription within the innermost ring: *Typus proiectionis Annuli adaucti vt in Conslusione Lybri praelo commissi, Anno 1630 promisi*. There are numerous drawings in the *Grammelogia*, all of which, excepting the drawings of slide rules on the engraved title-pages of *Grammelogia IV* and *V*, were printed upon separate pieces of paper and then inserted by hand into the vacant spaces on the printed pages reserved for them. Some drawings are missing, so that the Bodleian *Grammelogia IV* differs in this respect slightly from the copy in the British Museum and from the British Museum copy of *Grammelogia V*.

In *Grammelogia I* the first three leaves and the last leaf are without pagination. The first leaf contains the title-page; the second leaf, the dedication to the King and the preface "To the Reader;" the third leaf, the description of the Mathematical Ring. Then follow 22 numbered pages. Counting the unnumbered pages, there are altogether 30 pages in the pamphlet. Only the first three leaves of this pamphlet are omitted in *Grammelogia IV* and *V*.

In *Grammelogia III* the *Appendix* begins with a page numbered 52 and bears the heading "Conclusion;" it ends with page 68, which contains the same two poems on the mathematical ring that are given on the last page of *Grammelogia I* but differs slightly in the spelling of some of the words. The 51 pages which must originally have preceded page 52, we have not seen. The edition containing these we have designated *Grammelogia II*. The reason for the omission of these 51 pages can only be conjectured. In Oughtred's *Epistle* (p. 24), it is stated that Delamain had given a copy of the *Grammelogia* to Thomas Brown, and that two days later Delamain asked for the return of the copy, "because he had found some things to be altered therein" and "rent out all the middle part." Delamain labored "to recall all the bookes he had given forth, (which were many) before the sight of *Brownes Lines*." These spiral lines Oughtred claimed that Delamain had stolen from Brown. The title-page and page 52 are the only parts of the *Appendix*, as given in *Grammelogia III*, that are missing in the *Grammelogia IV* and *V*.

Grammelogia IV answers fully to the description of Delamain's pamphlet contained in Oughtred's *Epistle*. It was brought out in 1632 or 1633, for what appears to be the latest part of it contains a reference (page 99) to the *Grammelogia I* (1630) as "being now more then two yeares past." Moreover, it refers to Oughtred's *Circles of Proportion*, 1632, and Oughtred's reply in the *Epistle* was bound in the *Circles of Proportion* having the *Addition* of 1633. For convenience of reference we number the two title-pages of *Grammelogia IV*, "page (1)" and "page (2)," as is done by Oughtred in his *Epistle*. *Grammelogia IV* contains, then, 113 pages. The page numbers which we assign will be placed in parentheses, to distinguish them from the page numbers which are *printed* in *Grammelogia IV*. The pages (44) – (65) are the same as the pages 1-22, and the pages (68) – (83) are the same as the pages 53-68. Thus only thirty-eight pages have page numbers printed on them. The pages (67) and (83) are identical in wording, except for some printer's errors; they contain verses in praise of the *Ring*, and have near the bottom the word "Finis." Also, pages (22) and (23) are together identical in wording with page (113), which is set up in finer type, containing an advertisement of a part of *Grammelogia IV* explaining the mode of graduating the circular rules. There are altogether six parts of *Grammelogia IV* which begin or end by an address to the reader, thus: "To the Reader," "Courteous Reader," or "To the courteous and benevolent Reader.," namely the pages (8), (22), (68), (89), (90), (108). In his *Epistle* (page 2), Oughtred characterizes the make up of the book in the following terms:

> In reading it.. I met with such a patchery and confusion of disjoynted stuffe, that I was striken with a new wonder, that any man should be so simple, as to shame himselfe to the world with such a hotch-potch.

Конец ознакомительного фрагмента.