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The English Carpenter's Rule and Notes on its Origins

by Paul B. Kebabian

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This limited study of the carpenter's rule was prompted by the acquisition of two English boxwood rules with tables and graduations that were unfamiliar to the writer. In an effort to determine an approximate date for the rules, and to understand the graduations, the investigation started with a 16th century source.

William Goodman, in his *History of Woodworking Tools* and Raphael Salaman, in the *Dictionary of Tools Used in the Woodworking and Allied Trades*, place the start of industrial manufacturing of modern boxwood rules in the early decades of the 19th century. This was the period during which the Rabone firm was established in Birmingham, England, and Belcher Bros. (1821), S. Morton Clark (ca. 1833), Hermon Chapin (1834), and E. A. Stearns (1838) were introducing factory production of accurately graduated boxwood and ivory rules in the United States. Prior to this time, rule making both in England and America had been largely in the hands of mathematical instrument makers or individuals who made their own — often imprecise — rules for linear and other measurement. Measuring devices for performing mathematical computation, for cask gauging, &c were also the product of the mathematical instrument maker.

Some two hundred and seventy-five years before the period of factory production, Leonard Digges, "Gentleman," published a significant contribution to the subject of mensuration entitled *A Boke Named Tectonicon*.[1] Digges, who died about 1571, studied at Oxford and subsequently became an accomplished architect, a student of optics, mathematician, surveyor, and author of several books on meteorology, military science, and on linear measurement and the measurement of solids. The *Tectonicon* had an unusual publishing history: sixteen editions or printings were made between 1556 and 1637. Digges explained that his purpose was to provide the Landemeater (surveyor), Carpenter, or Mason with a way to obtain "the true measurynge and readye accompte of all maner of Lande, Timber, Stoone, Borde, Glasse, Pavement &c." Portions of the *Tectonicon* particularly relevant to the measurement of timber and boards, and the rule, are "A table to finde the just Radix or Square of any Tymber," and chapters on the table of timber measure, on superficial or board measure, and on the description and construction of the carpenter's rule.

The emphasis placed by Digges — and later by Richard More[2] — on the need to determine cubic measurement of timber by one lineal foot units, and also to make superficial measurement of boards by the square foot, was based on the fact that wood sold to the carpenter was then, as today, priced by per foot measurement. Thus the carpenter needed to know, for example, what length of a timber of certain dimensions of width constituted a cubic foot. His rule, by means of specific tables and graduations, could provide the answer if the timber were in cross-section an equal-sided square, if his rule was accurate, and if he knew how to use it. But if the sides were of unequal dimension, Digges explains, the untutored were accustomed simply to add the width and depth dimensions and halve the result, thereby obtaining an incorrect figure for applying to the rule to find what length would give one cubic foot.[3] With a square timber of 8 inches on each side, Digges' table for timber measure reads 2 feet 3 inches as the length of one cubic foot. But if the timber were of unequal widths — as 4 inches and 12 inches — and if one added these and divided by two the resulting 8 inch figure would be grossly incorrect for determining cubic measurement by means of the carpenter's rule. For one cubic foot of

Continued next page

the latter dimensions, the carpenter should get a piece some 3 feet long, rather than 2 feet 3 inches.

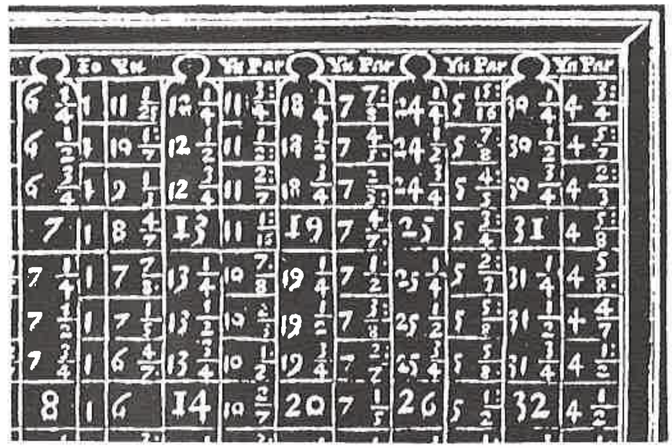
Digges provided a "Tabula Radicum" to give ready response to the question: What figure can be used with the table of timber measure to determine the length of a cubic foot of timber of specified, *unequal dimensions of width*. The coordinate of 4 and 12 and his Tabula, for instance, gives the figure "7." Opposite 7 on the table of timber measure is the answer: 2 feet, 11 2/7 inches. The single "pointe adjoyned" to the figure 7 of the Tabula Radicum was not a typographical aberration, but the introduction by Digges of one of the earliest examples of a qualifying mathematical symbol.[4] He explains that by one "prycke" beside a figure he means *a little quantity less than*, and by two points (:) *a fractional amount more than*. The square root of 4 times 12 is 6.928 or not quite 7, the figure to be used with the table of timber measure. It would not be possible to accommodate a series of whole and fractional decimal figures on a table, and of necessity the figures of Digges' tables are in certain instances but close approximations.

Square Ynches of the tymbre	Foote	Inches	Partes
1	144		
2	36		
3	16		
4	9		
5	5	9	3/23
6	4		
7	2	11	·2/7
8	2	3	
9		21	1/3
10		17	·2/7
11		14	·2/7
12		12	
13		10	:1/3
14		8	:13/16
32		1	11/16
33		1	·5/6
34		1	·1/2
35		1	3/4
36		1	1/3

Fig. 1— Copy of part of the timber measure from *The Tectonicon*. For "Square Ynches," read "Inches Square."

Following the tables and discussion of timber measurement, Digges provides a square foot board measure table and instructions for its use. The columns are headed "Fo" and Yn" for foot and inches, for width of board, glass, &c from 1/4 to 12 inches by quarters of an inch, and "Yn" and "Par" for inches and parts of inches for material from 12 1/4 to 36 inches in width. The number of feet, inches, and fractions of inches in length that make a superficial square foot is given for each width dimension. Thus, opposite 6 inch width is the figure 2 feet, and opposite 25 inch width, the answer 5 3/4: inches (or slightly more than that length) per board foot.

Starting the chapter on the Carpenter's Ruler, Digges writes: *"Because the effect of this Ruler is above declared by Tables, an Instrument also wel knowen and commune amonge good Artifycers:*



	Fo	Yn		Yn	Par		Yn	Par		Yn	Par		Yn	Par
6 1/4	1	11 1/25	12 1/4	11	3:/4	18 1/4	7	7:/8	24 1/4	5	15:/16	30 1/4	4	3:/4
6 1/2	1	10 1:/7	12 1/2	11	1/2:	18 1/2	7	4/5:	24 1/2	5	7:/8	30 1/2	4	5:/7
6 3/4	1	9 1/3	12 3/4	11	2:/7	18 3/4	7	2/3:	24 3/4	5	4:/5	30 3/4	4	2:/3
7	1	8 4/7	13	11	1:/13	19	7	4/7:	25	5	3:/4	31	4	5:/8
7 1/4	1	7 7/8:	13 1/4	10	7./8	19 1/4	7	1:/2	25 1/4	5	2:/7	31 1/4	4	5/8.
7 1/2	1	7 1/5	13 1/2	10	2/3	19 1/2	7	3:/8	25 1/2	5	5:/8	31 1/2	4	4/7
7 3/4	1	6 4/7:	13 3/4	10	1:/2	19 3/4	7	2:/7	25 3/4	5	5/8:	31 3/4	4	1:/2
8	1	6	14	10	2/7	20	7	1/5	26	5	1:/2	32	4	1/2

Fig. 2— A section of Digges' table of board measure.

I will not spende many woordes, in opening it. Behold the fyguers, and learne by them howe ye ought to make, and commonly to decke youre Ruler, bothe with Tymber and bourde measure."[5] We note that Digges uses the term *board measure*. Strictly speaking, a board foot is a measurement including thickness. That is, a piece of wood 12 inches by 36 inches represents 3 superficial square feet; if one inch thick, it is 3 board feet (if of two inches thick, 6 board feet &c). Popular usage through the centuries has given to the superficial measurement of lumber the term "board" measure. That Digges uses "bourde measure" in 1562 would indicate that 16th century measurement of sawn boards was then, as now, based on boards of 1 inch thickness. Edmund Gunter, however, writing in 1624, preferred the term "broad measure."[6]

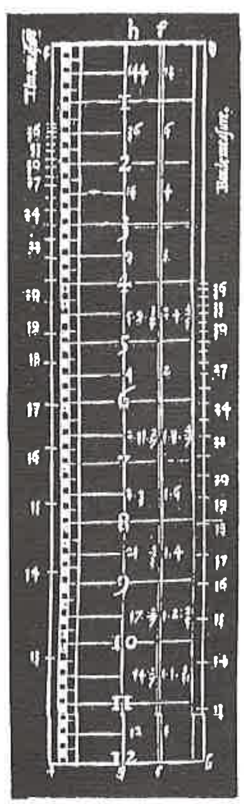


Fig. 3— Digges' carpenter's rule. Timber measure graduations are to the right of the line g h, and continue on the left edge of the rule. Board measure graduations are on the line f e, and on the right edge b d.

Digges describes the ruler as "*wel playned, twelve Inches longe, a quarter of an Inche thicke, and two Inches yn breadth. Truly yt were more commodious if it hath two foote in length.*" The 12 inch ruler he illustrates is scaled in inches, and half, quarter, and eighths of the inch. The timber measure is then added to the rule by writing or graving the proper figures, taken from his table of timber measure: near 1 inch on the rule is marked 144 (feet); 2 inches, 36 (feet); 3 inches, 16 (feet); &c to 12 inches, 12 (inches). The second figure represents the running length to make one cubic foot from 1 inch, 2 inch, 3 inch &c of square timber. Instructions are given for continuing the square timber scale on the rule for material up to 36 inches on a side, by inserting the numbers 13 to 36 on the 1/4 inch thick side of the rule at their appropriate places according to the figures of the timber table. In a similar manner the figures for board measure are to be marked on the face of the rule, and continued along the second or opposite 1/4 inch wide edge.

Digges does not stop at this point, but makes of his carpenter's rule a rather sophisticated instrument. He gives directions for marking on the back a "Quadrant Geometricall" with a 90° scale, for mounting a tiny plummet on a fine thread to hang from the quadrant, and attaching level sights "wel bored...made of wode, or rather metall," to be fastened on one edge of the rule when it is to be used for sighting.

Forty-six years following the first edition of the *Tectonicon* Richard More of London published *The Carpenter's Rule*. This 1602 work is addressed to "The Worshipful, The Master, Wardens, and Assistants of the Companie of Carpenters of the Citie of London..." The author, himself a member of the Company, affirms that gross errors are constantly being made in the measurement of timber. The most common resulting in loss to the buyer are purchasing "waynie" or twisted-growth timber and measuring it as square, and secondly "taking halfe the breadth and thickness of a peece being added together, for the square thereof." More gives full credit at more than one point to Digges: "The ordinarie Rule which Carpenters, Shipwrights, and others doe use to measure Timber withall," he notes, "was invented and published by Paster Leonard Digges." However, he finds that most rules are "very false" and that "those divisions or strikes which are set on them for measuring of Boord and Timber, are not in their right places."[7]

More describes a variety of ways to measure boards and planks and makes a case for using an arithmetical method. He provides instructions for measuring square, rectangular, round, oval, waynie, and taper growth timber. In chapter 12 of part 2, he includes tables for timber and board measure, with illustrations of the tables which are based essentially on those of Digges. More does not describe or illustrate a graduated carpenter's rule, but his references to Digges and his timber and board measure tables suggest that the construction of the instrument and its graduations and other markings had undergone no significant change from 1556.

The expansion of knowledge in the field of mathematics which took place in the 17th century, however, was to result in new scales being added to the carpenter's rule. John Napier published his work on logarithms in a Latin edition of 1614, followed by a translation in English in 1616.[8] Based on the work of Napier and other contemporary mathematicians, logarithmic lines of numbers were developed by Edmund Gunter, and in his 1624 work on the sector he described "The use of the line of Numbers in the boarde measure, such as boord, glasse, and the like," in "solid" or cubic measure, and in "Gaugeing of vessels." The invention of the rectilinear slide rule, using two juxtaposed rules with Gunter's lines, is generally credited to William Oughtred.[9] It is this invention that subsequently became an essential part of the carpenter's slide rule.

Coggeshall's *Timber-Measure by a Line of More ease*...(i.e., a modified Gunter's line) was made public in this 1677 pamphlet,[10] and Thomas Everard's *Stereometry*, on cask gauging by use of his slide rule, was first published in 1684. Coggeshall's sliding rule is carefully described in the 1728 first edition of Chambers' *Cyclopaedia*[11] and in subsequent editions at least through the 7th of 1751-52. It is this rule, in a two foot, two fold form with Gunter's line as modified by Coggeshall that persisted into the 20th century in both England and America.

The 1728 Chambers description of Coggeshall's sliding rule reads substantially as follows:[12] it is principally used in measuring the superfices and solidity of timber, &c. It consists of two rulers, each a foot long, which are framed or put together in various ways: sometimes they are made to slide by one another, like glaziers rules: sometimes a groove is made in the side of a common two foot joint rule, and a thin sliding piece put in, and Coggeshall's lines added on that side (the method used in 19th century American manufacture): the most usual way is to have one of the rulers slide in a groove made along the middle of the other. Coggeshall's carpenter's slide rule utilized Gunter's lines for the A, B, and C scales but the fourth scale, "called the girt-line, and noted D, whose radius is equal to two radius's of any of the other lines, is broken for easier measurement of timber...." The D line is graduated from 4 to 40, and is so illustrated on Coggeshall's rule in the plates of Chambers' *Cyclopaedia*.

The two English boxwood rules here illustrated in Figs. 4 and 5 bear graduations for board and timber measurement consistent with the tables developed by Digges. They also carry Gunter's line (two lines figured 1 to 10 as described by him in 1624 rather than Coggeshall's A,B,C,& D scales). To perform arithmetical calculations it is necessary to use dividers.[13]

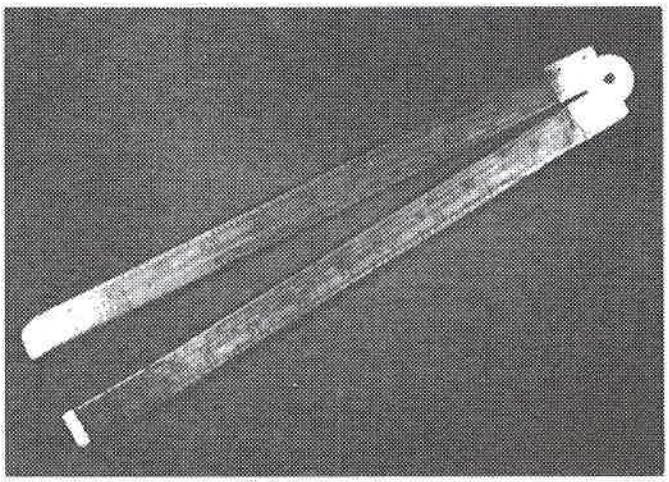


Fig. 4— The 2 foot, 2 fold boxwood carpenter's rule.

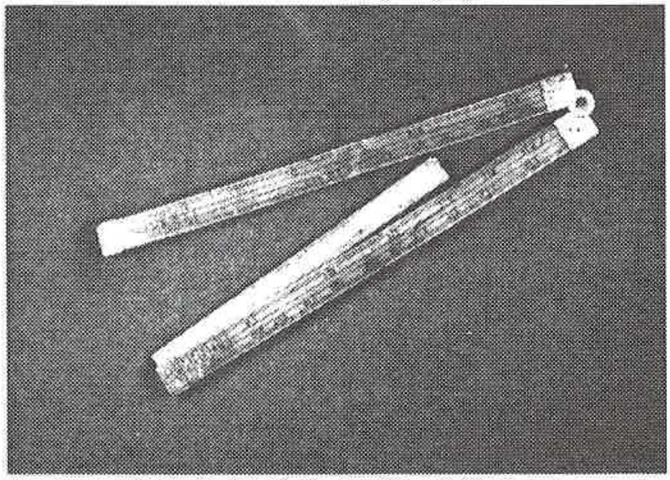


Fig. 5— The 2 foot, 3 fold rule of two hinged 9 inch legs and a 6 inch brass hinged extension.

The tables of Fig. 6, which represent those of the two rules, provide for superficial or board measure and for timber or cubic measure of wood up to 6 inches wide, and 8 inches wide, respectively. Both of the rules also include *lines of board and timber measure* which extended the tabular data for dimensions beyond 6 and 8 inches in width. As Digges and More explain in their books, the figures 1 to 6 of the board measure table represent inches of breadth, the second and third lines the feet and inches of length that make a square foot for the corresponding width figure on the top line. Thus, a board 1 inch wide requires 12 running feet to make 1 board foot; a board 5 inches wide requires 2 feet and four inches to make one board foot.

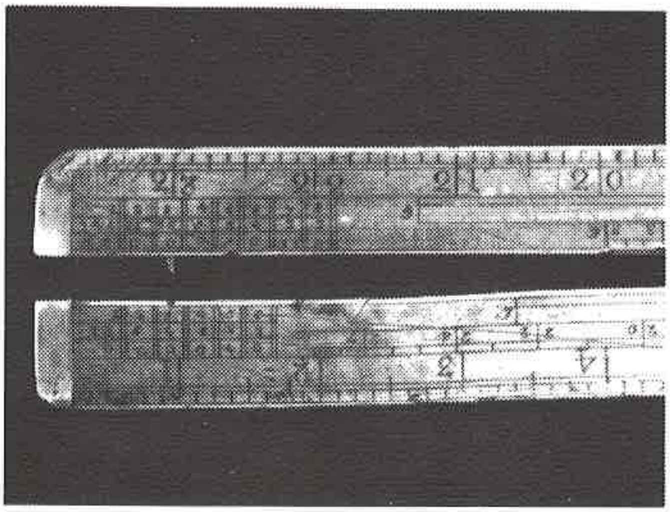


Fig. 6— Tables of timber (above), and board measure (below) on the 2 fold rule.

The line of board measure (graduated for 7 to 36 inch widths on one rule and 9 to 36 on the second) is used as follows: a figure for width, such as 11 inches, is located on the line. The rule is turned over, and on the 24 inch scale of the back side, and opposite the location of 11 on the first side, is found 13 1/16 inches. Thus a board 11 inches wide measures approximately 13 1/16 inches in length per board foot. That rule makers considered it necessary to provide for measurement of boards 30 inches and more in width speaks to the dimensions of trees being cut for timber (or perhaps being imported for sale) in England in the 16th and 17th centuries.

The top line of the table of timber measure reads 1 to 8, representing figures for square timber of 1 to 8 inches width on each side; the second and third lines are the number of running feet and inches required for one cubic foot. Thus a 4 inch square of timber requires a piece nine feet long to yield one cubic foot; or if a 6 inch square, a length of 4 feet for one cubic foot. For square timber more than 8 inches on the sides, one uses the line of timber measure (graduated for 9 to 30 inch widths on the first rule pictured, and 11 to 30 inch widths on the second). In using this line one measures — using a second rule to perform the measurement — from the figure for width per side, to the end of the rule: for example, from 11 on the line of timber measure to the end of the rule measures approximately 14 1/4 inches. That is to say, an 11 inch square sided timber (or a timber of unequal width sides, the square root of whose product equals 11) contains 1 cubic foot for every 1 foot 2 1/4 inches of length.

These applications of the tables and lines are also explained in the editions of Chambers *Cyclopaedia* from the 1st edition of 1728 through the 7th in 1751-52 (and possibly later editions not available to the writer). Curiously, there is a substantial error in the example given for use of the board measure table which persists through all the editions noted, viz, "if a surface be one inch broad, how many inches long will make a superficial foot? Look in the upper row of figures for one inch, and under it in the second row, is 12 inches, the answer to the question." Unfortunately, the example errs not only by giving the wrong answer, but by asking the wrong question. The second row of the board measure table gives measurements in feet and not inches, and the question should ask now many feet make a superficial foot for a surface 1 inch wide, and the answer from the table is 12 feet. It is apparent that Chambers' work was considered a most authoritative source (as it was). The *Builders Dictionary* of 1734, borrowing virtually word for word from Chambers, contains the same error.[14]

That the two foot, two fold rule was in general use by 1728 is apparent from reading the descriptions of Coggeshall's sliding rule in Chambers, where this rule with Gunter's line is explained. Making use of the "common" 2 foot joint rule by inserting the slide with logarithmic scale is stated as one method of constructing it. One could conclude that between Digges and More (1556/1602), and the first edition of Chambers (1728) the 2 foot, 2 fold carpenter's rule had become a standard form of measuring instrument. Its illustration with tables and lines of board and timber measure in the 7th edition of Chambers is very similar to the rule in Fig. 4 above. In 1758 Edmund Stone's translation of Bion's book on mathematical instruments was published in a 2nd edition with Stone's "Additions of English Instruments." Stone's first example (Book I, p. 14) describes the construction and use of the "Carpenter's Joint-Rule." Both in textual description and illustration in the plates, the rule is again similar to that of Fig. 4. Both rules are professionally made, and neither bears a maker's name. It would seem reasonable to suggest that these two English rules are of late 17th to mid-18th century manufacture, and that the 3 fold rule with 6 inch brass leg is probably somewhat later than the 2 foot example.

FOOTNOTES

[1] Digges, Leonard. *A Boke Named Tectonicon.* London: Thomas Gemini, 1562. It is of interest that in his imprint Gemini notes that his location is within Black Friars and that he is "there ready exactly to make all the Instruments apperteynynge to this Booke." The first edition published by Digges was dated 1556.

[2] More, Richard. *The Carpenters Rule, Or, A Booke Shewing Many plaine waies, truly to measure ordinarie Timber*. . . London, 1602. Reprint. New York: Da Capo Press, 1970.

[3] Digges, leaf 11 recto.

[4] Cajori, Florian. *A History of Mathematical Notations.* 2 v. Chicago: Open Court Pub. Co. (1928-29) v. 2, p. 197.

[5] Digges, leaf 17 verso.

[6] Gunter, Edmund. *The Description and use of the Sector. The Crosse-staffe and: other instruments.* London, 1624. Reprint. New York: Da Capo Press, 1971. *The first Booke of The Crosse-Staffe,* p. 31-50.

[7] More. p. 2.

Continued next page

Further Notes on the Early English Three Fold Ship Carpenters Rule

by Paul B. Kebabian

The two foot rule illustrated in Figure 2-1 was described in some detail in the author's THE ENGLISH CARPENTER'S RULE AND NOTES ON ITS ORIGINS. Its two boxwood nine inch legs, a six inch brass hinged extension, 24 inch graduations, tables and lines of timber and board measure, and its Gunter's lines for mathematical calculations were identified. Two additional sets of graduations (on the sides reverse to those bearing the board and timber measures) were not, however, discussed. The reasons for these omissions were that the article was primarily concerned with the board and cubic measures of the two fold and three fold rule; that the writer was ignorant of the functions of the two sector lines on the rule; and that he overlooked the line of figures that constitute an early introduction of an octagon scale. It is these latter series of graduations — the sectors with nautical designations and the octagon scale — that clearly bring the tool from the general description of *carpenter's rule* to the more specific, i.e., *ship carpenter's rule.*

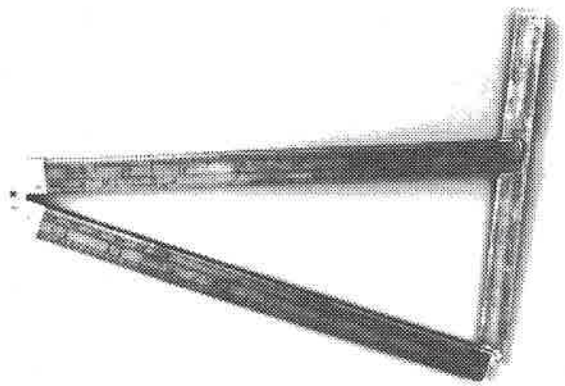


Fig. 2-1 — The two foot, three fold shipwright's rule with sectors and octagon scale.

One of the earliest illustrations of a three fold rule of this type (Fig. 2-2) is in the 1691 Swedish work on shipbuilding by Ralamb.[1] Although his representation of the rule, no. 7 & 8 of plate K, is not sufficiently detailed to show accurate graduations, it does clearly reveal two sector lines. The rule is described as 7 "Een Tumstak", a (*folding*) rule, and 8 "Tungan nti en Engelst Tumstak af 1 1/2 fot lang", *Tongue of an English rule of 1 1/2 foot length.* The description of length seems ambiguous (1 1/2 rather than 2 feet), but it is likely that the author identifies at no. 8 the six inch tongue leg which is hinged to no. 7, a two fold part of 18 inches length, rather than suggesting that the rule is 1 1/2 feet long overall. The "English" attribution of this rule is of interest in the light of rule 9 & 10 (Fig. 2-2) and which appears to be a ship carpenter's bevel with graduated body and tongue. Nicolaes Witsen's Dutch shipbuilding text, *Architectura Navalis et Regimen Nauticum*, 2nd ed., 1690, contemporary with Ralamb, shows no three fold rule in the illustrations of shipwright's tools.

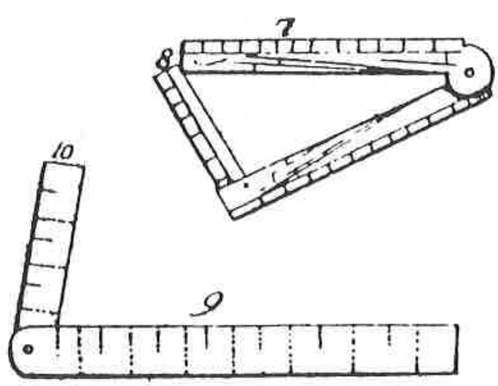


Fig. 2-2 — Rules illustrated on plate K by Ralamb in 1691. 7-8 is the three fold "English" rule with sector, and 9-10 a "Dutch" bevel.

FOOTNOTES, *continued*

[8] Napier, John. *A Description of the Admirable Table oe (sic) Logarithmes.* London, 1616. Reprint. New York: Da Capo Press, 1969.

[9] Cajori, Florian. *William Oughtred.* Chicago: Open Court Pub. Co., 1916. p. 47. See Also: Nicolas Bion. *The Construction and Principal Uses of Mathematical Instruments. Translated from the French. . . by Edmund Stone.* 2nd ed., London, 1758. Reprint. London: Holland Press, 1972. Book I, p. 16.

[10] Coggeshall, Henry. *Timber-Measure by a Line of more ease, dispatch and exactness, then any other way now in use, by a double scale...* London: Printed for the Author, 1677.

[11] Chambers, Ephraim. *Cyclopaedia: or, An Universal Dictionary of the Arts And Sciences...* 2 v. London: Printed for J. and J. Knapton (et al), 1728.

[12] Chambers. Entry under: Sliding rule — Coggeshall's Sliding rule.

[13] For an explanation of using Gunter's line see: *The Carpenter's Slide Rule, its History and Use.* Published by John Rabone & Sons. 3rd ed. Birmingham, 1880. Reprint. Fitzwilliam, NH: Ken Roberts, 1982. p. 8-10.

[14] *The Builder's Dictionary: or, Gentleman and Architect's Companion.* 2 v. London, 1734. Reprint. Washington: Association for Preservation Technology, 1981. Entry under: Rule. Figure 1 is slightly altered, reduced copy. Figures 2 and 3 are reductions from negative microfilm.

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One end of one of the boxwood legs of the three fold rule is laterally slotted to a depth of about five sixteenths of an inch, into which the six inch brass extension can be snugly fitted (see Fig. 2-1). This gives the instrument rigidity so that dividers can be used to take off accurate measurements from the sector lines. The inner sector lines on each of the boxwood legs are graduated P, 3Q, 2Q, 1Q and MH, representing Partners, third, second, and first Quarters, and Masthead. The function of this sector is to provide a series of diameter measurements for shaping the taper of a mast. Below decks mast dimensions are not taken into account by the sector measurements. The partners are the heavy timbers forming a supporting framework around the opening for a mast at the ship's main deck level. The mast head is here understood to be the top section of the lower mast (from which additional masts – topmast, topgallant, etc. – could be successively raised as required by the architecture and rigging of a particular vessel). The sector may be opened to an angle so that the distance between point P on each leg, using a pair of dividers, forms a convenient, arbitrary, transverse measurement, such as four inches. This transverse dimension, and the succeeding points 3Q, 2Q, 1Q and MH may then be measured with the dividers and laid off on a plan (see Fig. 2-3).

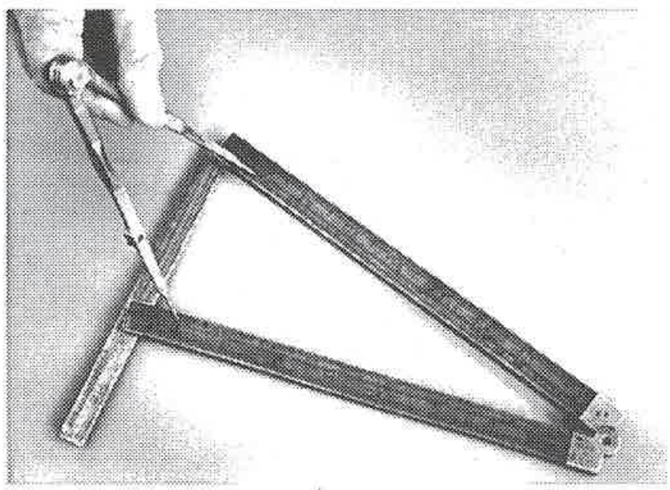

Fig. 2-3 — Making a measurement on the sector.

Anderson states that the manuscripts of Keltridge and Battine on shipbuilding, written in 1675 and 1684 respectively, agree that the diameter at the head of a mainmast or foremast should be two thirds of the diameter of the mast at the partners.[2] Duhamel du Monceau, writing some eighty years later, gives the same 2/3:1 proportion for diameters of the mast.[3] It is of note that the figures obtained by use of the sector on the rule give a masthead dimension that is precisely two thirds of the diameter at the partners (see Fig. 2-4).

The second, or outer set of the two sector lines are designated S, 3Q, 2Q, 1Q and YA, for Slings, third, second and first Quarters, and Yardarm. The slings are the middle part of a yard, where it is suspended by rope or chain from the mast; the yard's function is to support a square or other shaped sail. Yardarm is the term given the end sections of a yard; yardarms are of somewhat arbitrary length, extending from the quarters to the extremities of the yard, and in lateral dimension they may include the outer, or first quarter. This second set of sector lines is used to determine diameter measurements at various points on the length of either half of a yard, from slings to yardarm end.

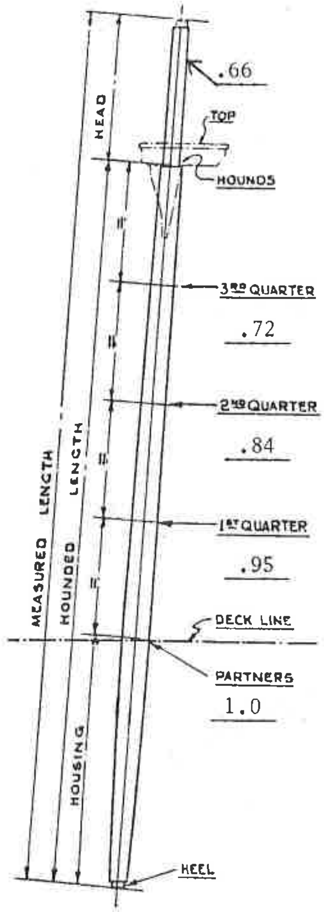

Fig. 2-4 — Mast diagram from *Masting and Rigging* by Underhill. The figures for diameter proportions obtained from the mast sector of the rule, on an arithmetical base of 1 at the partners, have been added at partners, quarter, and masthead.

The diameter of a yard at its ends should be one third of the diameter at the slings, according to Keltridge.[4] Again, the results of measurement by the sector are reasonably consistent with Keltridge's 1675 dimensions. For example, a three inch setting on the rule at the sector points for S gives a transverse measurement of only slightly more than one inch at the Y graduations. A work dealing with more modern sailing ships by Underhill includes a table of diameter dimensions for timber yards that are proportionately of somewhat greater size at the yardarms than the Keltridge figures.[5] For example, a yard of twenty-one inch diameter at the slings measures nine inches at the yardarm, or about 3 to 1.28, rather than 3 to 1.

It is probable that in shaping a spar, 20th century shipwrights carry on long-standing, traditional techniques. A log is squared by the broadaxe, further reduced to an octagonal spar by hewing, and rounded by the mast drawing knife and spar plane.[6] Anderson, in describing Lord Pembroke's ship model of 1692, the 1701 model of the St. George, and others of the early years of the 18th century, reports that the lower yards had an octagonal section at the slings.[7] An octagon scale is included on the three fold rule (Fig. 5). It would have been an obvious convenience for the shipwright to measure and lay out construction lines to reduce the square of a yard to an octagon, while portions beyond the center were rounded and tapered to dimension. The eight square line of this three fold rule is graduated with figures 0 to 28, and is of the type referred to as an "M" or middle scale on 19th century rules.[8] A dimension taken from the scale would be measured to right and left from the mid-points of the squared sides of a yard, rather than from the corners, to mark the layout lines.

To review the data of the three fold rule of Fig. 2-1, it bears tables and lines of a board and timber measure developed during the 17th century. Two Gunter's logarithmic lines on the outer narrow edges of the rule are consistent with that mathematician's descriptions published as early as 1624. On the other hand, the rule does not incorporate the more convenient sliding lines of numbers which were developed in the latter part of the 17th century by Oughtred, Coggeshall (1677), and Everard (1684). It provides sectors for determining the taper of masts and yards, the octagon scale, and two foot scale graduated in inches for linear measurement.

Further utility of the rule as a ship carpenter's tool has been suggested in that two simultaneous angle measurements can be made for compound bevels by use of the two boxwood legs and the third, brass leg. Taken together, the scales and graduations of this versatile member of the measuring instrument family suggest that it was probably a product of the latter part of the 17th century, or the early decades of the 18th century.

FOOTNOTES

[1] Ralamb, Ake Classon. *Skeps Byggerij eller Adelig Ofnings.* Stockholm, 1691. Facsimile reprint, 1943. Plate K.

[2] Anderson, R. C., *Seventeenth-Century Rigging; a Handbook for Model-Makers.* London: Percival Marshall, 1955, p. 9.

[3] Duhamel du Monceau, Henri Louis. *Elemens de l'Architecture Navale; Traite Pratique de la Construction des Vaisseaux.* Paris: C-A. Jombert, 1758, p. 135.

[4] Anderson, p. 29.

[5] Underhill, Harold A., *Masting and Rigging the Clipper Ship & Ocean Carrier.* Glasgow: Brown, Son & Ferguson, 1949, p. 258.

[6] Story, Dana A., *The Building of a Wooden Ship.* Barre, Mass.: Barre Publishers, 1971. *(Two unnumbered pages describe and illustrate shipwright Arthur Gates making masts).*

[7] Anderson, p. 30.

[8] The octagon, or eight square lines are commonly found on 19th and 20th century two foot, two fold, carpenters' rules of both English and American manufacture. Both a middle line (M), and edge (E) scales are frequently provided.

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Book Reviews

A SHORT HISTORY OF THE PRINTED WORD, by Warren Chappell, Dorset Press, New York, 1989 (originally 1970). XVIII + 244 + XV pages, 203 illustrations, 12 page bibliography. $15.95.

Printing from moveable interchangeable types has been a tremendous force during the last 500 years in the spread of education. Usually attributed to Johann Gutenberg in the 1440's, it is one of the first, if not the first, making of interchangeable parts to close limits. It would seem that the idea was not strictly original as earlier printing from moveable wooden types, possibly as early as the 1520's is popularly attributed to Laurens Janszoon Coster of Haarlem in Holland, who died in 1440. The quality of both the type making and printing which has survived from this early Dutch work is so inferior to that of Gutenberg's bible of c-1555 that, although it pointed the way, it can hardly be said to have been commercially or widely acceptable.

The early printing was very clearly done in imitation of the manuscript books that had preceded it. It was, of course, much less expensive due to the speed with which duplicates could be made. Just the change from individually carved wooden type to metal type cast in a permanent mold form which many castings could be quickly made introduced a very important economy in the preparation prior to actual printing. It's most noticeable shortcoming was the lack of ease in the use of many colors, particularly in illustrations, as was so common in manuscript books. Partly off-setting this were many new styles of type which, in their own right, introduced a new style of graphic art.

This book pays much attention to the evolution of typefaces and also describes in detail the cutting of typefaces and the casting and finishing of the type. The numerous methods of producing illustrations is also described in detail and the various later type casting techniques such as the Linotype and Monotype machines, the process of lithography which is so dominant today, and the appearance of the newspaper under the influence

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