

A Note on the Wooden Carpenter's Rule from Odyssey Shipwreck Site 35F

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In 2006 Odyssey Marine Exploration recovered one half of a wooden folding rule from site T7a35f-5, a shipwreck heavily impacted by the offshore fishing industry and located at a depth of 110m in the Western Approaches to the English Channel. The 1ft-long object is one half of a distinctive type of carpenter's joint rule with a design that is characteristically English. The artifact is extremely rare and the earliest example found on a shipwreck. The very limited comparative examples on land suggest a possible date of manufacture for the instrument between the 1660s and 1690s.

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1. Scale Identification

The 1ft-long wooden artifact recovered by Odyssey Marine Exploration in 2006 from site 35F in the Western Approaches to the English Channel is a single arm from an originally 2ft-long folding rule (Figs. 1-3). It features a series of lines, numbers and letter abbreviations incised into three sides. These scales (Kingsley, 2008) are the key to identifying and dating the instrument.

1. Side A has three scales (Figs. 1, 3, 5-10):

- a. An inch scale [0]-12, divided to unit, half, quarter, eighth and numbered by 1. This would have continued to 24 on the missing leg.
- b. A pair of scales labelled C and D (Fig. 10), standing for 'Circumference' and 'Diameter'. The two scales share the same format: each begins with a subdivided segment and then a scale of equal parts from [0] to the limit imposed by the length of the rule.

2. Side B has three elements (Figs. 2, 3, 11-15):

- a. The end of a line of board measure running from 12 (at the hinge) to 36, each unit subdivided to half. The scale ends 4in from the end of the leg ($4 \times 36 = 144 = 1\text{ft square}$).
- b. The beginning of a line of timber measure from 9 to 12 (at the hinge), each unit subdivided to quarter.
- c. A table of timber undermeasure. This is continuous

with the timber line and supplies values for 1 to 8in, which the rule cannot accommodate on the scale line.

3. The edge carries a logarithmic line of numbers 1-10 (Fig. 4). The missing leg would have carried the same scale to make a double radius line 1-100.

2. Mathematical Formulas

Side B for timber and board measure was designed to be used for measuring areas and volumes. This particular format was established during the 17th century as an adaptation of a design first published by Leonard Digges in 1556 (Knight, 1988; see Johnston, 1994 for the 16th-century development, and Johnston, 2006 for a detailed study of an unusual straight carpenter's rule of 1635). The complete instrument would have had a board line running from 7 to 36, with a table of undermeasure from 1 to 6in at the end of the missing leg. The timber line would have run on to 36 on the other leg, terminating 1 1/3in from the end.

The logarithmic line of numbers on the edge was first published by Edmund Gunter in the 1620s. In the form found here, which appeared on a range of instruments in the 17th century, it would have been used with a pair of dividers or compasses as a general-purpose calculator – in effect, a slide rule.

The most distinctive scales are those marked C and D (Fig. 10). They would have been used with compasses or dividers and are interrelated. If the circumference of a log had been measured with string, the scales provided the diameter without calculation. These scales would have been matched by another pair on the missing leg, most likely labelled SE for 'Square Equal' and SW for 'Square



Fig. 1. Site 35F wooden folding rule side A with an incised inch scale numbered [0]-12 inches and divided into half, quarter and eighth units.



Fig. 2. Site 35F wooden folding rule side B incorporates three elements. Inner scale: the end of a line of board measure running from 12 to 36, each unit subdivided to half. Outer scale: beginning of a line of timber measure from 9 to 12, each unit subdivided to quarter. Far left: table of timber undermeasure.

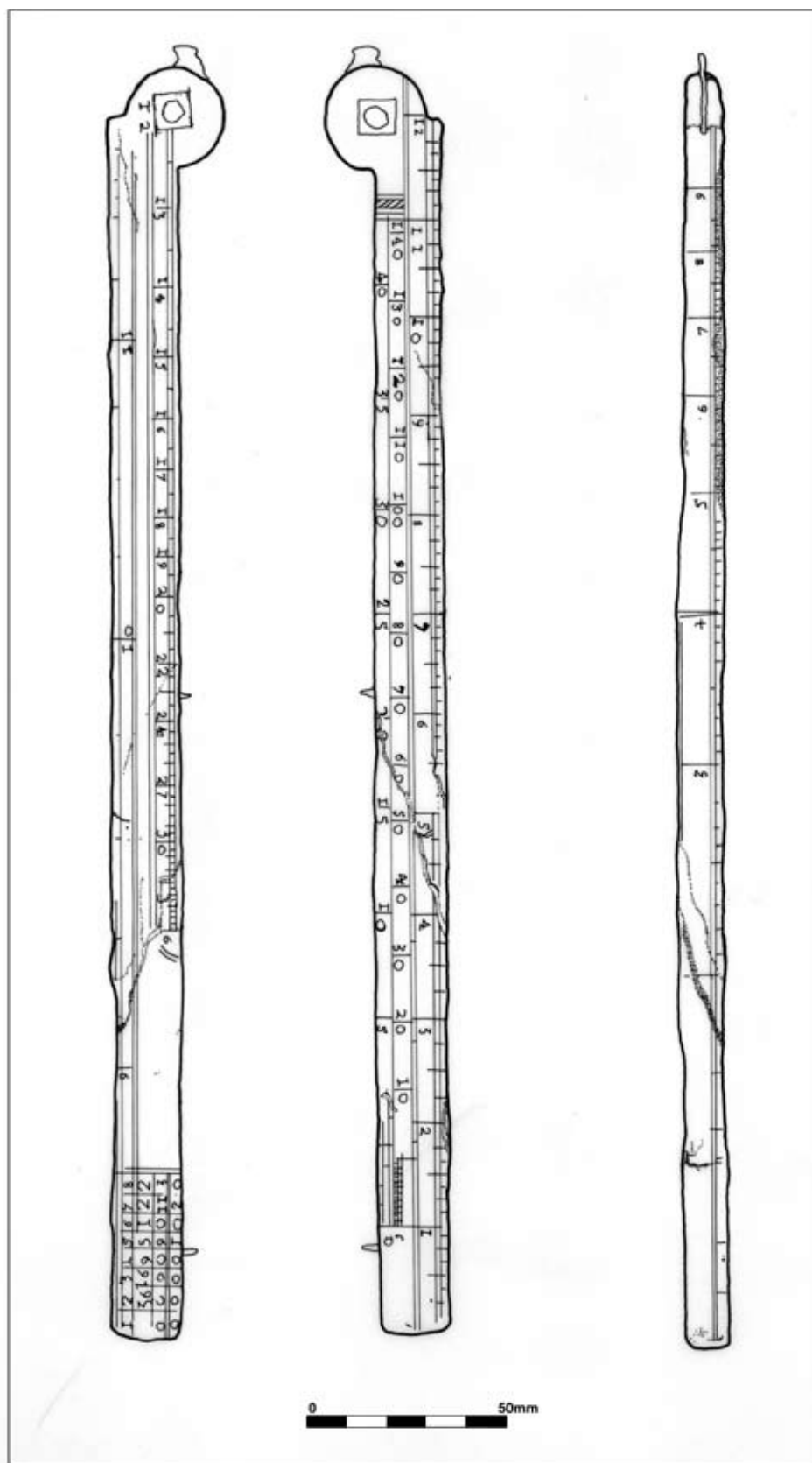


Fig. 3. Drawing of the one arm of the wooden folding rule from site 35F (inv. no. 0010). Left: Side B. Centre: Side A.

Within'. Given any one of these four dimensions, the others can be determined without arithmetic.

For example, to find the diameter of a log with a circumference of 108in, first one foot of a pair of dividers would have been placed on the 100 mark of C, while the other foot would have been extended to the 8 division on the subdivided segment. Keeping the dividers separated, this length would have been transferred to the D scale so that one foot was on a numbered division and the other was in the subdivided segment: the rule would show about 34½in as the diameter. The C scale is simply the D scale multiplied by π (pi), since $C = \pi D$. The approximation used here is not the standard one of $2\frac{2}{7}$, but a less accurate one of about $3\frac{1}{8}$. (The disparity is easily seen from the scales. When $2\frac{2}{7}$ is used, the divisions for 100 and 30 coincide since, taking account of the subdivided segments, they actually represent 110 and 35.)

The SE and SW scales would have been constructed in a similar way. The square equal provided the side of a square whose area equalled the circle defined by the circumference; squaring this value (easily done with the logarithmic line) provided the cross-sectional area of the circular log. The square within (also known as the inscribed square) gives the side of a square that fits within the circle and hence provided an indication of the usable timber that could be extracted from the log.

3. Historical Context & Chronology

The presence of the C and D scales provides the best clue for dating the instrument. They were first referred to in print in 1661 by the mathematical instrument maker John Brown, who provided an explanatory diagram. Brown's discussion was introduced without fanfare as simply 'The use of four scales, called Circumference [sic], Diameter, Square equal, Square inscribed'. This brief account appeared in his *The Description and Use of a Joynt-Rule* (London, 1661: 87, 107-8) at the end of a chapter entitled 'The use of certain lines for the mensuration of superficial and solid bodies, usually inserted on Joynt-Rules for the use of Work-men, of several sorts and kindes', which suggests that the scales were already known by this date.

There is some evidence, however, from surviving instruments that these scales were a relatively recent innovation. The Science Museum collection in London retains an instrument (inv. 1954-292) to the same design as the 35F example, which is dated to 1659 (Fig. 16). The four scales are fully labelled as circumference, diameter, square equal and square within. This suggests a degree of unfamiliarity regarding terminology, which had evidently been over-

come by the time the 35F example was manufactured and could use the abbreviations C and D.

The Science Museum example remains the earliest currently known that features all four scales. A unique instrument, however, in the National Museums Scotland, Edinburgh (inv. 1978-92), incorporates three of the scales found on the site 35F example. This is a 3ft, three-fold brass carpenter's rule, evidently made in London but inscribed '1655 Robert Trollap of yorke free mason' (Fig. 17). Like the 35F example, it was designed for board and timber measure, and also has an inch scale and a double radius logarithmic line of numbers. It includes three unlabelled scales for circumference, diameter and square equal. There is space where a fourth scale for square within could have been inserted. Its absence suggests that the four-scale pattern, as exemplified on the site 35F wooden rule, was created in the later 1650s.

Prior to their introduction as scales on rules, the problem of the interrelation of these four dimensions had been treated as a topic for the logarithmic line of numbers. When first announcing the logarithmic line in 1623, Edmund Gunter's *De sector & radio. The Description and Vse of the Sector in Three Bookes. The Description and Vse of the Cross-Staffe in other Three Bookes* (London, 1623: 35-6) provided problems interrelating the circumference, diameter and square equal. Presumably Gunter was the inspiration for the scales on the 1655 instrument now in Edinburgh.

In 1645 Edmund Wingate expanded Gunter's logarithmic problems in *The Use of the Rule of Proportion in Arithmetique and Geometrie* (London, 1645: 65-6) to include the inscribed square. He was followed in 1656 by John Brown's *The Description and Use of the Carpenters-Rule together with the Use of the Line of Numbers (inscribed thereon) in Arithmetick and Geometry* (London, 1656: 53-5), which described the function of the straight 2ft carpenter's rule. Brown, therefore, may have been responsible for the instrument pattern that the 35F example follows.

How long-lived was this particular pattern of carpenter's rule? The characteristic set of four scales was mentioned as an optional extra for joint rules by John Brown in 1677 and they were still current in 1688 when he added their use to a new impression of his *The Description and Use of the Carpenters-Rule*. The latest example of an instrument carrying the 'circle-square' scales currently known is dated to 1685 and is held today at Colonial Williamsburg (inv. 1997-100). In addition to a set of four unlabeled circle-square scales, this carries the familiar complement of board, timber and logarithmic scales, but in a different physical format: it is a three-fold rule, with two 9in wooden legs and a (now broken) folding brass extension piece to complete the full 2ft length (Figs. 18-19).



*Fig. 4. Detail of the side edge of the folding rule incised with a logarithmic line of numbers 1-10.
(The missing leg would have carried the same scale to make a double radius line 1-100.)*



Fig. 5. Detail of the hinge end of side A.



Fig. 6. Detail of the hinge mechanism at the folding end of side A.



Figs. 7-8. Detail of side A.



Fig. 9. The end section of side A.



Fig. 10. Detail of the end section of side A with a pair of scales incised 'C' and 'D', standing for 'Circumference' and 'Diameter'.



Figs. 11-13. Detail of side B.



Fig. 14. End section of side B with table of undermeasure at right.



Fig. 15. Detail of table of undermeasure on side B.



Fig. 16. An intact wooden folding rule in the collections of the Science Museum, London, was crafted to the same design as the site 35F instrument, and is dated by an inscription to 1659. Its four central scales are fully labelled as circumference, diameter, square equal and square within. Photo: © Science Museum, London (inv. 1954-292).



Fig. 17. A unique 3ft, three-fold brass carpenter's rule in the National Museums Scotland, Edinburgh. It shares scales with the site 35F example and appears to be a prototype for the overall design. Though crafted in London, it is inscribed '1655 Robert Trollap of yorke free mason'. Photo: © National Museums Scotland (inv. 1978-92).



*Fig. 18. A three-fold rule at Colonial Williamsburg (inv. 1997-100) with inch scale to 18in and the remains of a 6in brass extension piece. The central 'circle-square' scales are unlabelled.
Photograph: permission of the Colonial Williamsburg Foundation.*



*Fig. 19. Detail of the three-fold rule at Colonial Williamsburg signed 'Robart Blake 1685', with an alternating stamped fleur-de-lys. Blake may have been the owner, rather than maker.
Photograph: permission of the Colonial Williamsburg Foundation.*



Fig. 20. A two-fold, 2ft rule engraved 'N P 1678' in the collection of Colonial Williamsburg (inv. 1995-18). This carries the same arrangement of scales as the site 35F rule, here showing the face with timber and board lines and tables. Photograph: permission of the Colonial Williamsburg Foundation.

It seems reasonable to place Odyssey's site 35F rule in the period between the 1660s and the 1690s. Although no more than an educated hunch, the 1670s or 1680s might be considered most likely. The closest known surviving example is found at the Science Museum, London, dated to 1674 (inv. 1936-33). Another similar example at Colonial Williamsburg is dated to 1678 (inv. 1995-18) (Fig. 20). Both Williamsburg examples have differently applied brass protective end-pieces, perhaps suggesting a different workshop style. The expansion of manufacture could be further investigated by a closer comparative study of the punched numeral forms, as well as additional variations in constructional detail. There are presumably further surviving examples currently lying unidentified in other public and private collections. These may in time shed additional light on the origins of the site 35F rule.

Acknowledgements

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