Kilderkins, Hogsheads & Dipping Rods: A Brief History of the Slide Rule

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For years collectors and major libraries have been seeking out and acquiring original works on the history of science. These collections of reference works dealing with the history of science provide immensely valuable resources for researchers who recognize that by studying and understanding the history of science we can better appreciate the achievements of the present.

Such collections include the conceptually revolutionary works of Nicolaus Copernicus, Johannes Kepler, Galileo Galilei, John Napier, and Isaac Newton. But how did these profoundly important works, framing new concepts, become accessible and useful to the layman of that day? The practical application of such knowledge was essential to emerging professional groups, such as ship navigators, surveyors, and carpenters. To help answer the question, we must turn to surviving books written for lay audiences and semiprofessionals on technical subjects.

Under the traditional apprentice system, practical knowledge was passed from journeyman to apprentice. Instruction manuals rarely were available to supplement on-the-job training, and were often simply worn out by usage or eventually lost when the owner waded a creek with the manual in his pocket. Later generations saw little reason to preserve Grandfather's tattered work manual. Today, the few manuals that have survived are being snapped up by collectors and archival libraries. They represent a small window into the past and tell us something of the training of skilled workers and semiprofessionals of the day.

One example of the practical application of an abstract mathematical concept can be seen in the invention of logarithms, which greatly facilitated mathematical calculations and led to the development of the slide rule.

John Napier

The chronicle of the slide rule is the record of society's continuing effort to ease the burden of tedious mathematical computations. Through the development and refinement of the slide rule, a few talented people contributed immensely to facilitating mathematical calculations, and thus to the more efficient use of time. The conceptual origin of the slide rule can be traced to John Napier (1550-1617), the Baron of Merchiston, who was both a Scottish theologian and a mathematician. He invented logarithms, a term he coined, and succinctly set forth the purpose of his new invention in his *Mirifici Logarithmorum Canonis Descriptio* (A Description of the Marvelous Canon of Logarithms) published in 1614:

> Seeing there is nothing (right well beloved Students of Mathematics) that is so troublesome to mathematical practice, nor doth more molest and hinder calculators, than the multiplications, divisions, square and cubical extractions of great numbers, which besides the tedious expense of time are for the most part subject to many slippery errors, I began therefore to consider in my mind by what certain and ready art I might remove those hindrances. [1]

Napier's remarkable achievement is all the more impressive, considering that he was sixty-four when he published his paper. He spent most of his life not as a mathematician, but as a leader of bitter political and theological controversies. He was a passionate and uncompromising Protestant and an outspoken critic of the Church of Rome. His work, *A Plaine Discovery of the Whole Revelation of Saint James,* is prominent in Scottish ecclesiastical history as the earliest Scottish work on the interpretation of the scriptures. Although Napier might have wished to be remembered as a theologian, by devoting most of his leisure to the study of mathematics, he ultimately distinguished himself as a brilliant mathematician.

On reading Napier's *Canon of Logarithms,* Henry Briggs (1561-1630), a mathematician at Gresham College, London, saw immediately the profound importance of this new concept. Within weeks he was on his way to Scotland to see Napier. So in awe of the man and his mathematical insight was he, that on being ushered into Napier's study, he stood in silent admiration for fifteen minutes. The two quickly became friends and discussed at length how logarithms could be most easily used in mathematical computations. Fortunately, Briggs' view prevailed that log tables should be calculated to the base 10.

Napier died three years after his remarkable work appeared, and the whole burden of calculating the new system of logarithms fell to Briggs, a task to which he devoted conspicuous ability, as well as unflagging energy. Henry Briggs was sixty-three when his *Arithmetica Logarithmica* was published in 1624. [2]

When logarithmic tables first became available they were especially useful in reducing the time required to make intricate astronomical calculations. This moved the great French astronomer and mathematician, Pierre-Simon Laplace, struck with the abstract grandeur of

Napier's invention, to quote Johannes Kepler who had declared that logarithms "by reducing to several hours the work of many months, doubled the life of the astronomer". [3]

Slide Rule Pioneers

In 1620, six years after Napier's milestone contribution to mathematics, Edmund Gunter (1581-1626), professor of astronomy at Gresham College, London, devised a straight 24-inch rule or scale which could be used for multiplication and division. He inscribed the numbers logarithmically rather than arithmetically as numbers appear on the common ruler. Thus, a pair of dividers or a compass was all that was needed to add or subtract segments on the rule and thereby multiply or divide them. Although the Gunter rule was more awkward to use than the slide rule, it continued to be sold until the end of the nineteenth century.

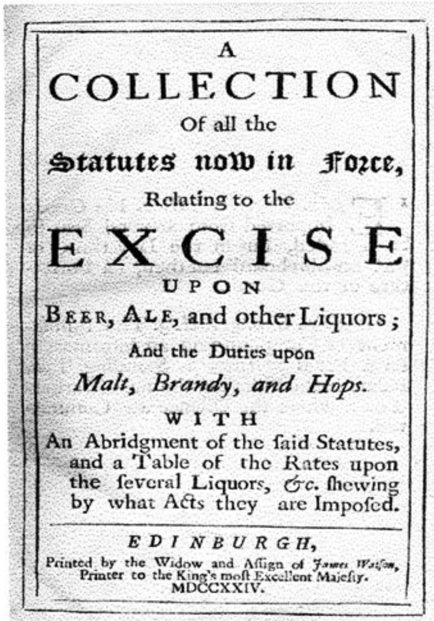
A year or two after Gunter's invention, English mathematician William Oughtred (1574-1660) positioned two Gunter rules to slide along each other, thus eliminating the use of dividers in performing calculations. His invention marked the beginning of the slide rule era. Oughtred also devised the circular slide rule (see the cover of this issue), a sound concept that had advantages over the familiar rectilinear design but never found the broad acceptance of the straight slide rule, possibly because of the difficulty in producing such devices. The long association of applied mathematicians with what today is euphemistically called the "alcoholic beverage industry" began in 1633 when the Vintners' Company asked Oughtred to design a slide rule to calculate the contents of wine vessels accurately. [4]

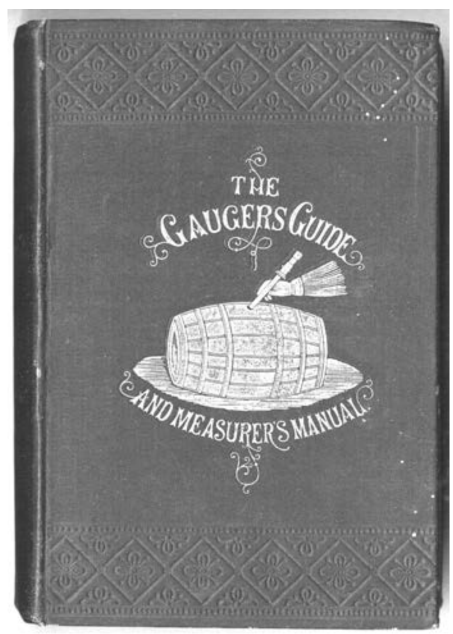
It was 1677 when Henry Coggeshall (1623-1690) described his slide rule, consisting of two rules with scales that slid past each other and were held together with brass strips. He also devised the "girt line" for calculating the board feet of lumber in standing timber and logs, taking into account the taper. Five years later Coggeshall conceived of putting the slide in one arm of a two-foot folding rule hinged at the center. This design was adopted by Joshua Routledge and numerous other rule makers in the nineteenth century.

English Excise Tax Slide Rules

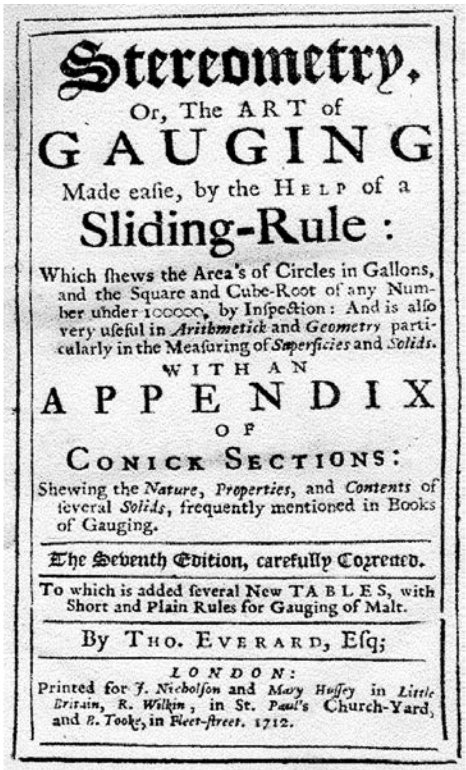
During the seventeenth century, England began an aggressive tax program to sustain its venturesome offshore activities, and to meet the costs of expanding military operations. Taxes were imposed on such diverse commodities as sweets, vinegar, glass, paper, soaps, and candles and, of course, taxes ultimately triggered the famous tea party in Boston Harbor.

The government quickly saw that alcohol could be an important source of tax revenue and began charging excise duties or taxes on ale, wine, and spirits in 1643. However, the calculation of taxes on alcohol was an intricate process compared to weighing and assessing the tax due, for example, on a batch of candy or soap. Given the calculations involved, academicians recognized that this would be a good application for the newly conceived slide rule.


A
COLLECTION
Of all the
Statutes now in Force,
Relating to the
EXCISE
UPON
BEER, ALE, and other Liquors;
And the Duties upon
Malt, Brandy, and Hops.
WITH
An Abridgment of the ſaid Statutes, and a Table of the Rates upon the ſeveral Liquors, &c. ſhewing by what Acts they are Impoſed.
EDINBURGH,
Printed by the Widow and Aſſign of *James Watſon*, Printer to the King's moſt Excellent Majeſty. MDCCXXIV.



This led to the preparation of gauging or excise tax manuals that candidates studied to become accredited customs officers. These gauging manuals, a direct link between Napier's invention of logarithms and the practical application of that concept, were written by academicians and so-called "philomaths" (lovers of mathematics), and covered such arcane subjects as mensuration (measurement) and stereometry (the measurement of volumes). At a time when simply being able to read was a significant accomplishment, the excise officer had to be a practical mathematician.



Stereometry,
Or, The ART of
GAUGING
Made eaſie, by the HELP of a
Sliding-Rule:
Which ſhews the Area's of Circles in Gallons, and the Square and Cube-Root of any Number under 100000, by Inſpection: And is alſo very uſeful in *Arithmetick* and *Geometry* particularly in the Meaſuring of *Superficies* and *Solids*.
WITH AN
APPENDIX
OF
CONICK SECTIONS:
Shewing the *Nature*, *Properties*, and *Contents* of ſeveral *Solids*, frequently mentioned in Books of Gauging.

The Seventh Edition, carefully Corrected.

To which is added ſeveral New TABLES, with Short and Plain Rules for Gauging of Malt.

By THO. EVERARD, Eſq;

LONDON:
Printed for *J. Nicholſon* and *Mary Huſſey* in *Little Britain*, *R. Wilkin*, in St. *Paul's* Church-Yard, and *B. Tooke*, in *Fleet-ſtreet*. 1712.

Well-thumbed copies of these pocket-sized books dating back to the seventeenth century occasionally appear on the shelves of antiquarian book sellers. The manuals explain the use of the slide rule and take the reader step-by-step through the process of calculating volumes of geometric shapes for use in determining the fluid content of containers. This task was complicated by the variety and shapes of the containers brewers, vintners, and distillers used. These included not only the familiar barrels and hogsheads but also now long-forgotten firkins, kilderkins, butts, puncheons, pipes, tuns, and long-breakers. After carefully measuring and dipping the cask to establish the fluid level, an excise officer faced the challenge of determining the liquid volume irrespective of whether the cask was standing on its end or lying on its side. Moreover, before 1824, when the imperial gallon was adopted as a standard measure, excise officers had to contend with ale and wine gallons that were different.

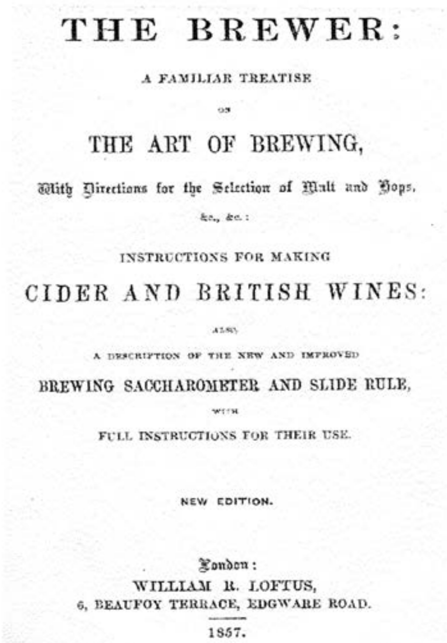
Once the fluid volume in gallons was established, the excise officer needed to determine its alcohol content – an easy task with a hydrometer, but until that device became generally available in the early 1800s, the excise officer carried a collection of philosopher's spheres or proof bubbles. These were hollow marble-like glass beads; fluid density or alcohol content upon which taxes were based depended on which of the calibrated spheres sank or floated.

In 1683, Thomas Everard, an English excise officer, began promoting a blocky slide rule for use in calculating excise taxes. Made of boxwood, it had two slides on opposing sides of a one-inch-square body. [5] Stimulated by the zeal of the Crown to collect all excise taxes due on ale, wine, and spirits, the use of Everard's slide rule caught on rapidly among excise officers. Thus, English excise officers were among the first to use the slide rule routinely in their profession.

Over a period of 150 years, the variety of slide rules used by excise officers multiplied. During the 1700s, Thomas Everard's two-slide boxwood rule evolved into a three-slide and then four-slide device with a slide on each face of its squarish cross section. Then in the 1800s, flat excise-tax slide rules appeared with both one and two slides. However, none of these slide rules had cursors (sometimes called runners or indicators). It took over two hundred years for the cursor to gain wide acceptance after it was first suggested by Sir Isaac Newton in 1675. [6]

By far the favorite material for making slide rules was boxwood (*Buxus sempervirins*). This European and Asian wood with its even, dense grain was ideal for engravers' blocks, measuring rules, and slide rules, as well as for chessmen. The production of a single slide rule presented several challenges. Clear-grained wood had to be selected, dried, and then shaped with hand tools. Slides had to be carefully fitted to the body of the rule since ease of operation depended on the slide moving in its grooves with neither too mueh nor too little friction. Inscribing rules was a tedious task, given that every inscription had to be precisely located, after which the lines were cut and letters and numbers were stamped by hand. Inevitably, errors crept in as the attention of the craftsman wandered.

Seasoned excise officers who could afford the extra cost acquired handsome ivory slide rules trimmed in German silver, a white alloy of nickel, zinc, and copper which was both attractive and durable. The rules were easier to read, but ivory was more brittle than boxwood, and greater care had to be exercised in making and using ivory slide rules. These elegant instruments must also have served to impress taxpaying merchants and pub owners who had no understanding of the operation of these strange "calculating sticks".


THE BREWER:

A FAMILIAR TREATISE

ON

THE ART OF BREWING,

With Directions for the Selection of Malt and Hops, &c., &c.:

INSTRUCTIONS FOR MAKING

CIDER AND BRITISH WINES:

ALSO,

A DESCRIPTION OF THE NEW AND IMPROVED

BREWING SACCHAROMETER AND SLIDE RULE,

WITH

FULL INSTRUCTIONS FOR THEIR USE.

NEW EDITION.

London:
WILLIAM R. LOFTUS,
6, BEAUFOY TERRACE, EDGWARE ROAD.
1857.

Traditionally, each neighborhood had its pub or "tippling house" which, along with the church, served as a community gathering place. The proprietor was a versatile businessman, at home behind his bar and, in off hours, busy brewing ale, making wine, and distilling spirits for his thirsty customers. The excise officer and tax collector, in making his rounds as a representative of the Crown, carried considerable authority when he entered a pub, as may be seen from an early gauger's manual that quoted relevant statutes:

> If any common Brewer shall refuse the Gauger to enter into his House, Brew-House or any other House or Place belonging to him, and to see his Coppers or other Vessels, or shall deny to show the Beer or Ale made by him, he shall forfeit for every such Denial the Sum of fifty Pounds, and be also presently forbidden by the Officer, to carry or deliver any Beer or Ale; which if he shall nevertheless do, he shall forfeit double the Value of all such Beer or Ale. [7]

There were numerous prohibitions on pub owners selling products without a license or selling products that had not been duly assessed by an excise officer. However, the life of the excise officer was not all drudgery, as the law also provided that "every Gauger has a right to taste Drink in Inn-keepers Cellars, and upon Inn-keeper's refusing, he is to forfeit five pounds". [8] Records do not reflect how this ready access to the pub owner's products may have affected gauging accuracy.

F.C. Farmar, another English customs officer, was granted a series of slide rule patents from 1899 to 1908. His 24-inch "Farmar's Wine and Spirit Merchants' Rule", with its logo "The Standard for the Entire Trade", represents the culmination of English excise rules. These boxwood rules, trimmed in brass, had numerous scales, allowing the user to determine the liquid contents of standing or lying casks, as well as to make various profitability calculations and volumetric conversions, and to adjust the proof or alcohol content of liquid inventories.

The Spirit Merchant: A Manual for the Information and Use of Persons Engaged in Every Branch of the Wholesale and Retail Spirit Trade, London 1870.

The Routledge-Type Slide Rule

Joshua Routledge of Bolton, England, an engineer himself, employed the Coggeshall design in 1805 in developing his two-foot hinged rule for engineers. While it was called an "engineer's rule", it was more of a journeyman's or tradesman's tool than a precision device that engineers could use in design work. Having no cursor, the slide rule was inscribed with two, two-cycle logarithmic scales, one sliding opposite the other, resulting in an effective scale length of 5.2 inches and limiting its accuracy accordingly.

The slide was centered in one arm, and immediately below it on the other arm appeared a series of tables for use by engineers in performing common calculations of the day. The tables included conversion factors, geometric information, and "gauge points" to assist in calculating steam-cylinder diameters for pumps lifting water to given heights. The steam-engine gauge points reflect the prevalence of such equipment in providing municipal water supplies and in dewatering mines.

The five separate engineering tables on the Routledge slide rule contained 168 numbers comprised of 501 separate digits, each individually hand-stamped on the boxwood or ivory. This labor–intensive effort inevitably led to mistakes; some errors were carried forward over the years and were even transferred from the rules of one maker to those of another as designs were pirated. In one instance, an erroneous gauge point appearing on an early engineer's rule was never corrected during some one hundred years of production in England and America, suggesting that users did not rely heavily on the tables inscribed on the rules. [9]

Routledge's engineer's rule, and the companion two-foot folding carpenter's rule with its girt line for lumber merchants, were initially manufactured in England. American rule makers in the Northeast quickly began adding similar slide rules to their own product lines. Among the early makers of Routledge-type slide rules in the United States were Belcher Brothers, New York (1821-1876) and C.A. Steams & Co., Brattleboro, Vermont (1838-1863). From the mid-1800s to the early 1900s, the dominant maker of boxwood and brass carpenter's and engineer's slide rules, as well as a wide assortment of boxwood measuring rules, was the Stanley Rule & Level Company of New Britain, Connecticut.

The Engineering Slide Rule

The origin of slide rules specifically designed for use by engineers can be traced to James Watt (1736-1819), the Scottish engineer and inventor of the separate steam engine condenser. At the age of nineteen, he was apprenticed to an instrument maker in London. Thus, it is not surprising that after returning north to join Matthew Boulton at Soho, outside Birmingham, his work with steam engines led him to develop a more accurate slide rule. Watt found that available slide rules such as those used by excise officers and carpenters were coarsely divided and unsuitable for use in machine design. He commissioned the preparation of a series of slide rules up to 56 inches in length with simple but precisely calibrated scales for his own use and for use by his design engineers. [10]

By greatly improving the efficiency of the steam engine, James Watt gave new impetus to the industrial revolution. He also recognized the fundamental importance of speed and accuracy in performing engineering calculations, and his so-called Soho rule ushered in a new era in the evolution of the slide rule. From that point on into the twentieth century, inventors and instrument makers produced a series of increasingly sophisticated and accurate slide rules for use by technicians and engineers.

An important contribution to the evolution of the engineer's slide rule was made by the English physician Peter Mark Roget (1779-1869). He is best known for his *Thesaurus of English Words and Phrases* which went through twenty-eight editions in his lifetime. A remarkably talented man with diverse interests, he presented a paper in 1815 to the Royal Society of London, introducing the concept of "log log scales" for use in making exponential calculations involving fractional powers and roots. [12] However, Roget's concept languished until the beginning of the twentieth century, when the American slide rule maker Keuffel & Esser (K&E) offered the first commercially successful log log slide rule for use in making thermodynamic, electrical, and other engineering calculations involving transient phenomena and fractional roots.

The utility of the English slide rule was quickly recognized on the Continent. The French made a number of significant contributions to the development of the slide rule. Beginning with Etienne Lenoir (1744-1832), French instrument makers produced elegant slide rules that were more finely calibrated, and thus more accurate, than rules produced in most other countries.

In 1850 Lieutenant Amédée Mannheim, a nineteen-year-old French artilleryman who later became Professor of Geometry and Stereotomy at the École Polytechnique in Paris, designed a slide rule that, for years, bore his name — the Mannheim Slide Rule. He devised an arrangement of scales using both sides of the slide that facilitated slide rule calculations. In addition, Mannheim developed the slide rule cursor, a runner with metal projections having fine lines for transferring readings from one set of scales to another; however, even after its introduction, it took time for Mannheim's cursor to become widely accepted. With the development of the glass indicator and its etched index line in 1890 the cursor became a standard slide rule feature.

Before adoption of the cursor, a series of innovative slide rule designs appeared, allowing users greater calculating flexibility. These late nineteenth and early twentieth-century rules included one devised by English engineer Thomas Dixon and another, The Engineer's Slide Rule, produced by Scofield Thacher of Youngstown, Ohio. These ingeniously designed cursorless slide rules had one-, two-, and even three-cycle log scales inscribed on both slides to permit several operations to be performed at a single setting.

The venerable German firm Dennert & Pape, which became Dennert & Pape Aristo-Werke in 1956, began producing slide rules in 1872. The company quickly recognized that the dimensional stability of ivory scales was not satisfactory, and in 1886 the firm was granted a German patent for white celluloid scales laminated onto mahogany stocks which soon became the accepted standard for slide rule construction. K&E depended on Dennert & Pape as well as a French firm for its slide rules from about 1880 until the turn of the century, when the company began producing its own rules.

A visit to Europe by two Japanese in 1894 to observe industrial developments sparked the formation of the company which became Hemmi or Sun-Hemmi, the so-called K&E of Japan. The Japanese visitors quickly recognized the importance of the slide rule in facilitating technological development and saw that Japan needed to produce its own rules. The first challenge the Japanese faced was finding a wood suitable for making slide rules. After a series of tests, a bamboo from Kagoshima Prefecture, Kyushu, was selected as being the most dimensionally stable under a range of temperature and humidity conditions. In 1929, Hemmi began exporting slide rules to the United States under a marketing arrangement with the Frederick Post Company of Chicago. [13] The intricately laminated Hemmi slide rules found wide acceptance as smoothly operating instruments of quality, and in 1963 the company set a record by producing one million rules.

A major American contribution to the evolution of engineering slide rule design was made by K&E's mathematical consultant William Cox, who devised a rule having scales on both the front and back surfaces with a double-faced indicator allowing readings to be easily transferred from one side of the rule to the other. This versatile duplex design quickly became the engineer's favorite, and K&E became the premier maker and marketer of slide rules.

In spite of formidable competition, both domestic and foreign, K&E is credited with producing more slide rules than any other company in the world. Beginning in 1950, Pickett produced a broad line of highly competitive metal and plastic rules, some in bright yellow, which was said to ease eye strain. One tactic the Frederick Post Company used to promote sales was to advertise on protective dust jackets given to students for their textbooks.

K&E offered the American engineer's favorite slide rule, the Log Log Duplex Decitrig, from 1939 to 1967. The endpoint in the evolution of the engineer's slide rule was the company's Deci-Lon slide rule, which appeared in the early 1960s as the successor to the Log Log Duplex rule. It was a well-designed, sophisticated slide rule that could be used in solving problems many engineers would not encounter in a lifetime, but production abruptly ended with the appearance of the hand-held calculator in 1972.

In Pursuit of Accuracy

Calculations on a typical 12-inch slide rule with a 10-inch scale can be made to an accuracy of three decimal places; for example, the product of π (3.14159 ...) and 2 can be read as 6.28 but not as 6.28318. This degree of accuracy is sufficient for many applications, and since it is faster than punching numbers into a calculator, some "old timers" still prefer using their trusty "slip sticks" in making preliminary analyses and scoping out problems.

However, the standard slide rule with its 10-inch scale was often inadequate for finalizing technical calculations and in banking and insurance fields, where greater accuracy was required. Increased accuracy could be achieved by calibrating rules more finely, but the success of this approach was limited by the maker's ability to inscribe rules and by the user's ability to read finely-divided scales. The preferred method of increasing accuracy was simply to increase the length of the scale. This too had limitations, as a slide rule much over two feet long was awkward to use and carry; thus other ways of lengthening the log scales were devised. This resulted in the development of a series of imaginative rectilinear, cylindrical, and spiral designs.

Edward Thacher patented his unique cylindrical slide rule with its horizontal bars in 1881. The instrument was first produced in London, and when Thacher transferred rights to K&E it began offering the rule in 1887. Despite its formidable appearance, Thacher's rule is nothing more than a series of linear scales totaling sixty inches, arrayed around a rotating cylinder, allowing the user to make calculations to four or five significant places. Although there was a relatively thin market for the instrument (fewer than 7,000 in total were sold), its utility in railroad, insurance, and steel company offices is attested to by the fact that K&E continued to offer it into the 1950s.

Another extended scale rule was Fuller's Spiral Slide Rule or Fuller Calculator, a cylindrical rule with a 42-foot spiral scale and an advertised accuracy of 1/10,000. Initially, this cumbersome 17-inch-long device had to be held by hand, but the development of a brass fitting affixed to its mahogany box made it easier and less tiring to operate. The Fuller rule was available in the U.S. through K&E from 1895 to 1926 and in England through W.F. Stanley.

The handiest long-scale cylindrical slide rule was the compact British-made Otis-King Patent Calculator. Production of this 1-inch-diameter, 6-inch-long cylindrical device, extending to 10-1/4 inches for calculation, began in 1921 and continued for forty years. While accurate to four or five places, its use, like most long-scale rules, was limited to multiplication and division.

The "RotoRule", a circular log log rule developed by J.R. Dempster of Berkeley, California, in the early 1930s, was offered by Eugene Dietzgen Company as an alternative to rectilinear rules. This convenient 5-inch-diameter engineer's rule with its optional magnifier has a 12-inch circular C/D scale as compared to the 10-inch scale available on standard rectilinear rules. In addition, it has two spiral scales providing the accuracy of a 50-inch conventional slide rule.

Special-purpose slide rules are themselves interesting subjects for study. Innumerable special rules reached the market, but since production was generally limited they are not as common or as well documented as more conventional slide rules. Such rules began to appear soon after the invention of the slide rule itself, and the English excise rule is but one example of a slide rule specifically designed to meet a particular calculating requirement.

In looking back, it seems that a slide rule was designed for nearly everyone making repetitive calculations. At times, this desire to facilitate routine calculations appears to have been taken to extremes. For example, a 34-inch boxwood and brass slide rule inscribed "Harrow Mark Reducer" was devised to help teachers at Harrow School in northeast London find percentages when marking student papers. Another rule appeared on the market for handicapping race horses and racing dogs.

Many instrument manufacturers produced specialized slide rules for the military that never appeared in commercial catalogues. There were slide rules for artillerymen and for meteorologists, for aircraft navigators and for pilots to adjust bomb and fuel loads. The list goes on and on. A few special-purpose slide rules are produced even today.

Epilogue

Over the span of three-and-a-half centuries the slide rule was the calculating instrument of choice, first for English tax collectors and tradesmen, and then for technicians and engineers. Only forty years ago slide rules were the ubiquitous companions of engineering students and their professors alike. They were essential tools in engineering offices as well as in design and research laboratories. If, as Johannes Kepler said, logarithmic tables doubled the life of the astronomer, then slide rules might be said to have reduced by half or more the drudgery of engineering calculations.

However, the introduction of pocket calculators in the early 1970s marked the end of the slide rule and its 350-year reign as the preferred portable calculating device. Hewlett Packard introduced its new HP-35 electronic calculator somewhat tentatively in 1972, with sales hype directed to generations of hard-core slide rule users. The first operating manual referred to "Shirt Pocket Power" and boasted, "Our object in developing the HP-35 was to give you a high precision portable electronic slide rule. We thought you'd like to have something only fictional heroes like James Bond, Walter Mitty or Dick Tracy are supposed to own."

HP need not have worried about the reception of its HP-35. On getting their first electronic calculators, academicians and engineers alike quickly relegated their slide rules to desk drawers where they began gathering dust. Only lately has the slide rule re-emerged, this time as a sought-after antique. In the parlance of the antique trade, slide rules are no longer just outmoded calculating devices, but are "of historical interest and quite collectable". With this impetus, nine slide rule collectors met in Oakland in 1991 and formed The Oughtred Society to encourage the collection and study of slide rules. Our organization now has over four hundred members, publishes a scholarly journal twice a year (copies of which may be found in university and technical museum libraries), and holds annual meetings as well as regional meetings in the United States and Europe.

The wide variety of slide rules developed over 350 years continues to offer a fertile field of study. Rules still remain to be "discovered" and their uses explored. Resource libraries with a broad range of reference materials are essential to historians in ferreting out information on the history of science and applied technology. To this end, librarians routinely scan antiquarian bookseller catalogs in search of items that can add scope to a collection and provide glimpses of life in societies entering the Industrial Age. As a result, competition is growing among libraries and collectors for these increasingly scarce materials.

Notes

1. Napier, John, *Mirifici Logarithmorum Canonis Descriptio.* Edinburgh, Ex Officina Andraeae Hart, 1614, as quoted in *Handbook of the Napier Tercentenary Celebration, or, Modern Instruments and Calculation,* London, G. Bell & Sons, Ltd, 1914.

2. Briggs, Henry, *Arithmetica Logarithmica.* In folio. London, Exeudebat Gulielmus Iones, 1624. This monumental work records the logarithms of 30,000 numbers to 14 decimal places, from one to 20,000 and from 90,000 to 100,000, together with another 1,000 logarithms from 100,000 to 101,000. In publishing an incomplete set of log tables, Briggs recognized that, having pioneered the calculations, only time and labor were required to complete the tables. Adrian Vlacq, a Dutchman living in London, completed the calculations and published in 1628 a complete table of Logarithms from one to 100,000 to ten decimal places. For more on Henry Briggs, see *Dictionary of Scientific Biography.* New York, Charles Scribner, 1970, 2, p461- 463.

3. Napier, Mark, *Memoirs of John Napier of Merchiston, His Lineage, Life, and Times, with a History of the Invention of Logarithms.* Edinburgh, William Blackwood; London, Thomas Cadell, 1834, p329.

4. Taylor, E.G.R., *The Mathematical Practitioners of Tudor & Stuart England.* Cambridge, Published for the Institute of Navigation at the University Press, 1968, p64-65.

5. Everard, Thomas, *Stereometry, Or, the Art of Gauging Made Easie by the Help of a New Sliding-Rule.* London, Printed for Robert Clavel and Christopher Hussey, 1689, 19 ff. Also, see Nicolas Bion, *Traite de la Construction et des Principaux Usages des Instruments de Mathématique.* Paris, Chez la Veuve dej. Boudet, J. Collombat, et J. Boudot fils, 1709, as translated and edited by Edmund Stone. London, 1758, 22 ff. This work provides a comprehensive description of "Everard's Sliding-Rule for Gauging".

6. Cajori, Florian, *A History of the Logarithmic Slide Rule and Allied Instruments.* First edition, New York, The Engineering News Publishing Company, 1909, p21-23.

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