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William Oughtred – Rector of Albury 1610 - 1660

This talk was delivered in 2006. There is no recording.

There is a set of 16 slides for this talk.

William Oughtred

Rector of Albury 1610 - 1660

The Register of Rectors of Albury goes back to Alain de Pointon in 1250, but there is little recorded history about any of them until the beginning of the 17th. century, when William Oughtred, a brilliant mathematician was inducted as Rector in 1610. He is best known for his invention of an early form of the slide rule, and the introduction of mathematical symbols which we still use - the multiplication and plus and minus signs that we are all familiar with.

William Oughtred was born in the reign of Elizabeth 1 on March 5th. 1575, at Eton near Windsor. During his childhood Sir Francis Drake circumnavigated the globe in the Golden Hind, and the Spanish Armada was defeated. His father, Benjamin Oughtred, was a scrivener who taught writing at Eton College, where through his connections his son William was educated as a king's scholar. From there he went to King's College, Cambridge, entering in 1592. Three years later he became a Fellow of King's College, received his B.A. in 1596 and his M.A. in the year of 1600. At Cambridge Oughtred's studies

would have consisted predominately of philosophy and theology, and despite the fact that very little mathematics was taught at Eton or Cambridge at this time, he demonstrated an extraordinary interest and talent in all things mathematical. He wrote "the time which over and above these usual studies I employed upon the mathematical sciences I redeemed night by night from my natural sleep, defrauding my body and inuring it to watching, cold, and labour, while most others took their rest". Oughtred had already completed his first work entitled "Easy Method of Mathematical Dialling" by the time he had graduated from Cambridge.

An interesting description of Oughtred's appearance and lifestyle is given by a contemporary in John Aubrey's 'Brief Lives':- "He was a little man, had black hair and black eyes (with a great deal of spirit). His head was always working. He would draw lines and diagrams on the dust.He used to lie abed until 11 or 12 a clock, with his doublet on,....studied late at night,....went not to bed till 11 o'clock, had his tinder box by him, and on top of his bed-staff he had his ink-horn fixed. He slept but little. Sometimes he went not to bed in two or three nights, and would not come down to meals till he had found what he sought".

He was ordained an Anglican minister in 1603, and in 1604 became Vicar of Shalford, Surrey, the church he served was demolished in 1788. In the present Victorian church he is shown on the list of vicars but no other reference is apparent. At around the same time he married Christ-Gift

Caryll of Tangley (a renowned local family), they had nine sons and four daughters. In 1610 Oughtred resigned the Shalford benefice upon being offered the Rectory of Albury by Sir Edward Randyll of Chilworth, who at that time was Lord of Albury Manor. The living was worth £100 per annum,supplemented by tithes paid by the parishoners. He then settled at Albury as a parish priest, however neighbouring clergy considered him a pitiful preacher, the reason being he gave little time to the study of divinity but bent all his thoughts on mathematics. Whether or not this criticism was justified, Oughtred was an ordained minister of the church, the study of mathematics was a side issue, a recreational pleasure.

He would however have to counter far harsher criticism and malicious gossip - due to a somewhat unusual arrangement made between Sir George More of Loseley and himself. On the 18th. January, 1610, Sir George More patron of the living of Compton, granted the next presentation of the benifice to William Oughtred or "any other" nominated by him. John Tichborne D.D., tenant of Eastbury Manor, proposed that he should be the person nominated and entered into negotiations with Oughtred for the purchase of the next vacancy. But before the arrangement was finally settled the then Rector, Hugh Phillips, died in 1618. Oughtred then made a great show of occupying the benefice himself, he preached "divers times at the church", and procured the tithes of the parsonage to be

"sequestered into the churchwardens hands". Four months later he came to an arrangement with Dr.Tichborne who agreed to pay the sum previously arranged. But before his institution was accomplished the scandal of the sale of the living was freely discussed - gossip had it that John Tichborne paid £250 to William Oughtred, and that he would not have got the benefice otherwise, Oughtred being "a very hard and mean man". Subsequently a charge of simony (buying and selling of ecclesiastical privileges) was set in motion against John Tichborne. Unfortunately it has not been possible to discover the results of the trial in the Loseley Manuscripts, but it seems probable that he got off on some legal quibble. He signed the Compton "Churchwardens book" as parson in 1621 and remained rector of Compton until 1636,when he resigned the living.

It appears that Oughtred escaped any repercussions from the foregoing events, and through his writings was quickly gaining fame as a brilliant mathematician, although never formerly trained he clearly had a genius for the subject. During the 1620's, appreciating the need for good mathematics instruction, he began to take private pupils into his home and let them live there free of charge while under his tutelage. Of his many pupils some of the most famous were, mathematicians John Wallis and Richard Delamain, architect Christopher Wren., and astronomer Seth Ward (later Bishop of Salisbury). For Oughtred's mathematical fame, perhaps the most influential student was the son of the Earl of Arundel.

In 1628 Oughtred became maths tutor to Lord William Howard, son of the Earl of Arundel, and for a time lived in the Earl's London mansion, Arundel House, which occupied a large site on the north bank of the Thames at the east end of the Strand. Needing a suitable text to supplement his instructions he wrote out, in summary form, all that was currently known about arithematic and algebra. The Earl was so impressed by Oughtred's efforts on behalf of his son, that he became his patron and encouraged him to publish his work. "Clavis Mathematica" (The Key to Mathematics) was first published in Latin in 1631, the most important English mathematical treatise. Like all his works it was very concise, (in only 88 pages) it included a description of Hindu - Arabic notations and decimal fractions, and a considerable section on algebra. By the time the second edition of the work was released in 1658, the author's reputation had been cemented in the larger community of European scientists. Moreover, all English mathematicians for the next century, including Isaac Newton, learned algebra from "Clavis Mathematica".

But Oughtred is best known for his invention of an early form of the slide rule.The logarithmic slide rule was designed in response to the demands of the scientific renaissance that overtook Europe during Oughtred's lifetime. In 1620 astronomer and mathematician Edmund Gunter (1581 - 1626) of London, plotted a logarithmic scale along a single straight two foot long ruler, he added and subtracted lengths by using a pair of

dividers, operations equivalent to multiplying and dividing. About a year later Oughtred saw that a simpler, yet more sophisticated method of multiplication and division could be achieved by placing two logarithmic rulers side by side and using the position of the numbers relative to each other to calculate the result. Thus dispensing with the dividers Oughtred created the prototype of the modern slide rule.

The earliest form of slide rules were made of wood, ivory or even bamboo, and in several versions, each adapted for a particular academic discipline e.g. from astrology to topography, chemistry to mechanical engineering. The present form of the slide rule was designed in 1850 by a French Army officer, Mayer Amedee Mannheim, who introduced a transparent slab movable cursor.

In 1632 Oughtred published 'Circles of Proportion and the Horizontal Instrument', describing both a sundial and a circular form of ruler that operated like his linear slide rule; it was constructed using two concentric rings, one seated inside the other and both were inscribed with calibrated logarithmic scales. But there is however, good evidence to suggest that he had invented a circular form of slide rule years earlier and failed to publish it. Ironically this circular form of slide rule had been described in a book entitled "The Mathematical Ring" published in 1630 by Oughtred's former student Richard Delamain. Credit for the invention of the circular slide rule was claimed by both teacher and pupil.

Unfortunately a very heated argument ensued and to some extent this formed a cloud over the later years of Oughtred's life.It is generally believed that Oughtred and Delamain were independant inventors, Oughtred got there first but Delamain was the first to publish. Certainly Oughtred's 'Circles of Proportion' is more detailed and versatile than Delamain's 'Mathematical Ring'. Delamain was a big fan of the slide rule, arguing that mechanical aids helped people understand how to calculate - Oughtred was not. He did not publish his notes earlier because, "the true way of art is not by instruments, but by demonstration".History has ultimately granted Oughtred credit for the circular slide rule.

In the 1630's Thomas Howard, Earl of Arundel and Surrey, was Lord of Albury Manor. He was one of the greatest of early English private collectors and patron of artists and scholars. Oughtred's "Clavis Mathematica" had secured him a place in the Earl's scholarly circle. Both men enjoyed long and learned discussions in the Italian garden the Earl had created at Albury - indeed they were nearly killed together when a grotto collapsed. Also at Albury Park Oughtred would have met John Evelyn (the diarist) as a very young man, and the artist Czech emigre, Wenceslaus Holler, both of whom, like himself enjoyed the patronage and friendship of Thomas Howard. Holler did twelve etchings of Albury Park and portraits of both Evelyn and Oughtred.

Oughtred appears to have been more famous, and more esteemed

abroad than at home. A fact borne out at the beginning of the English Civil War (1642-49) when the Duke of Florence invited him to Italy, and offered him £500 per annum - a lucrative and tempting offer which he turned down on account of his religion, fearing he would be expected to convert to Catholicism if he accepted. Oughtred lived during turbulent times in England, a staunch supporter of the English crown, he was shocked by the execution of Charles 1st. in 1649, and viewed with suspicion the puritanically influenced government that desired to take the place of the monarchy.

In 1646 he was summoned to appear before the Committee of Ecclesiastical Commissioners where many articles had been deposited against him. Because of his Royalist sympathies he was in grave danger of being deprived of his living. The Reverend Anthony Smith, the incumbent of St. James', Abinger, had been sequestrated in the previous year for having spoken against the Parlimentarians in church. Fortunately for Oughtred,due to the quick action of astrologer William Lilly, many influential people of the day appeared in great numbers on his behalf, so he escaped sequestration.

During the Civil War, Surrey was dominated by Parlimentary forces - as an ardent Royalist he would have been in a very precarious position despite his influential friends. Whilst the records provide no evidence, it is thought that Oughtred had the wall painting of St. Christopher in the Old Parish Church plastered over during the Puritan regime in order to preserve it and possibly his own position as Rector.

He kept a low profile during the Commonwealth years (1649 - 60),quietly carrying out his pastoral duties and even redeeming himself with the local clergy as a preacher.During the final decades of his life he published six more books among them "Trigonometria" in 1657, one of the first works on trigonometry to use concise symbolism, and a number of more minor works on watchmaking, solving spherical triangles by the planisphere and methods to determine the position of the sun. His "Opuscular Mathematica" was published posthumously in 1676.

In the years before his death he burned a world of papers and printed books, it is said he would not stir until they were completely consumed by the flames. Presumably he was ensuring that no one could claim credit for his work after his demise - his dispute with Delamain over the invention of the circular slide rule had left its mark.

William Oughtred died on the 13th. of June, 1660, he had lived just long enough to see the re-establishment of the Stuart monarchy with the return of Charles II to the throne in May that year. Oughtred's friend Ralph Greatorex, the mathematical instrument maker, said "he conceived he died with joy at the restoration of the king". Oughtred was buried in the Old Parish Churh, Albury, on the north side near the screen between the chancel and the body of the church, but with no memorial to mark his grave. Furthermore, during the

Commonwealth period parish registers were not kept in churches so the deaths of neither Oughtred nor his wife were registered. Just some 16 years later John Aubrey had difficulty finding his grave, so he asked John Evelyn to speak to Henry Howard, 6th. Duke of Norfolk, Lord of Albury Manor, about bestowing a marble inscription stone to mark the grave. The fact that the request was never granted was most likely due to poor timing rather than indifference. The Duke, who suffered severe bouts of melancholy and lassitude, was at that time living in Weybridge at the house of his second wife, Jane Bickerton, which he had adopted as his base near London, in place of Albury. So for over three hundred years there was no memorial for Oughtred in the church, but in 1977 a small commemorative plaque was mounted on the east wall of the nave stating that he was the maths tutor of Sir Christopher Wren.

Much has been written about the works of William Oughtred, and his contribution to mathematical science. Many have visited the church where he spent a large part of his life - earning his place in history whilst serving as pastor of the parish of Albury.

Retta T.L.Casbard.

Reference Sources

i) "The Dukes of Norfolk", John Martin Robinson.

ii) "The Natural History and Antiquites of Surrey" John Aubrey

iii) "Brief Lives" John Aubrey

iv) The Oughtred Society

v) Sundial Society, Bulletin, Vol. 17(iii)

iv) Slide Rule Gazette Autumn 2000

vii) Various Internet pages.

viii) Loseley MSS.Vol.iv fol.82

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i) "The Dukes of Norfolk", John Martin Robinson.

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iv) Slide Rule Gazette Autumn 2000

vii) Various Internet pages.

viii) Loseley MSS.Vol.iv fol.82

List of Slides for talk on W.Oughtred

Intro. Albury Old Church - view from S.W.

1 William .Oughtred. Artist / date unknown

2 Shalford Church - pre 1788

3 Albury Old Church - view S.W. from Peak's engr'g 1758

4 Arundel House - detail from pictorial map of London Engraved by Wenceslaus Holler 1646 - showing Strand, Somerset House & the rambling Tudor Arundel House. The current house was built on site in 19th. century by Duke of Norfolk

5 William Oughtred date & artist unknown

6 Slide rule

7 18th Cent. ring - dial developed from the self orienting-dial ascribed to William Oughtred in the 17th. century

8 Circular slide rule - an early etching

9 Thomas Howard - the collector - Earl - 2nd. Earl of Arundel

10 Wensclaus Hollar etching of Albury Park 1646

~~11 John Evelyn - as a young man by Vann der Borcht~~

// ~~12~~ William Oughtred - by Wensclaus Hollar 1646
John Evelyn considered it a very good likeness

12 ~~13~~ St.Christopher wall painting

13 ~~14~~ Close detail of wall painting

14 ~~15~~ Oughtred's "Trigonometria"

15 ~~16~~ The Old Church - north side

page (3)

* In a tithing agreement dated 21st. September 1617, parishoners with seven calves in a year paid a tithe calf in kind, others, sixpence a cow with calf, and twopence for a barren cow, payable at Easter-tide, Also a tithe of three pence a lamb was due at St. Marks tide.

Old Rectory - Albury.

Footnote in Manning & Bray

quoting a deed by which Simon-de-Abrie grants to Alan de Pontis, Rector of Albury, 4 acres of land in Westhi Street.

Alan de Pontis instituted Rector in 1250 - 1285 - as the Rectory built for Pontis was between that date. Which ties in with the fact that a building of 13th cen. origin existed at the back of the Old Rectory until the early 20th century.

preacht (they sayd) admirably well, even in his old age.
He was a good Latinist and Graecian, as appears in a little
ıtise of his against one Delamaine, a Joyner, who was so
:y to write against him (I thinke about his Circles of
portion). Prop-
Nicolaus Mercator went to see him a few yeares before he dyed.
ıs about Midsommer, and the weather was very hott, and the old gent-
:leman had a good fire, and used Mr. Mercator with much
ınity (being exceedingly taken with his excellent Mathematicall
:) and one piece of his courtesie was, to be mighty importunate
ı him to sett on his upper hand next the fire; he being cold
with age) thought he had been so too.
Before he dyed he burned a world of Papers, and sayd that the world
.d was not worthy of them; he was so superb. He burned also
-rall printed bookes, and would not stirre, till they were Sever-
-umed. His son Ben was confident he understood Magique. cons-
He dyed the 13th day of June, 1660, in the yeare of his age
ıty-eight plus odde dayes. Ralph Greatrex, his great friend,
Mathematicall Instrument-maker, sayed he conceived he dyed
ı joy for the comeing-in of the King, which was the 29th of
before. And are yee sure he is restored? Then give me a
ıs of Sack to drinke his Sacred Majestie's health. His
'its were then quite upon the wing to fly away.
'he 15th of June he was buried in the chancell at Albury.
.d much adoe to find the very place where the bones of this
'ned and good man lay (and 'twas but 16 yeares after his dealt
:h). When I first ask't his son Ben, he told me that truly his
griefe for his father's death was so great, that he did not
'mber the place - now I should have thought it would have remem
: him remember it the better - but when he had putt on his
:idering cap (which was never like his father's) he told as cons-
'esaid, with which others did agree.
I have desired Mr. John Evelyn, etc., to speake to our
'one, the Duke of Norfolk, to bestowe a decent Inscription of
marble on him, which will also perpetuate his Grace's
'.

WILLIAM OUGHTRED

Rector of Albury 1610 - 1660.

An extract from Aubrey's 'Brief Lives'. 1626-97

(Born 1574. Mathematician. Educated at Eton and King's College Cambridge. Ordained 1603. Vicar of Albury in Surrey 1610. Published CLAVIS MATHEMATICAE 1631. Wrote CIRCLES OF PROPORTION and other works. He invented trigonometrical abbreviations and introduced the multiplication and proportion signs. Died 1660)

His Father taught to write at Eaton, and was a Scrivener; and understood common Arithmetique, and 'twas no small helpe and furtherance to his son to be instructed in it when a schoole-boy. His Grandfather came from the North for Killing a man. The last Knight of the Family was one Sir Jeffrey Oughtred. I think a Northumberland family.

Anno Domini 1610 he was instituted and inducted into the Rectory or Parsonage of Albury, in com. Surrey, worth a hundred pounds per annum: he was Pastor of this place fifty yeares.

William Oughtred, that was an Honour to the English Nation, maried Mrs. Caryl (an ancient Family in those parts) by whom he had nine sonnes (most lived to be men) and four daughters. None of his sonnes he could make scholars.

He was a little man, had black haire, and black eies (with a great deal of spirit). His head was always working. He would drawe lines and diagrams on the Dust.

His oldest son Benjamin, who lives with my cosen Boothby (who carresses him, and gives him his Dyet, and a little House near t lie in) and now an old man, he bound Apprentice to a Watchmaker; who did worke pretty well, but his sight now failes for that fir worke. He told me that his father did use to lye a bed till 11 or twelve a clock, with his Doublet on, ever since he can remembe Studyed late at night; went not to bed till eleaven a clock; had his tinder box by him; and on the top of his Bed-staffe, he had his Inke horne fix't. He slept but little. Sometimes he went no to bed in two or three nights, and would not come downe to meale till he had found out the quaesitum.

He was more famous abroad for his learning, and more esteeme then at home. Severall great Mathematicians came over into

and on purpose to converse with him. His countrey neighbours
hugh they understood not his worth) knew that there must be extr-
-aordinary worth in him, that he was so visited by Foreigners.
When Mr. Seth Ward, M.A., and Mr. Charles Scarborough, D.M.,
was in Pilgrimage, to see him and admire him, Mr. Oughtred
against their coming prepared a good dinner, and also he had ? dress-
sed himselfe, thus; an old red russet cloath-cassock that had bely
black in dayes of yore, girt with a old leather girdle, an ? old
fashion russet hatt, that had been a Bever, tempore Reginae Eliz-
abethae. When learned Foraigners came and sawe how privately he
lived, they did admire and blesse themselves, that a person of
such worth and learning should not be better provided for.
Seth Ward, M.A., a Fellow of Sydney Colledge in Cambridge
(Bishop of Sarum) came to him, and lived with him halfe a
e (and he would not take a farthing for his diet) and learned
his Mathematiques of him. Sir Jonas More was with him a good
e, and learn't; he was but an ordinary Logist before. Sir ? char-
les Scarborough was his Scholar; so Dr. John Wallis was his ? scho-
lar; so was Christopher Wren his scholar; so was Mr. Smethwyck,
S. But he did not so much like any as those that tugged and
e pains to worke out Questions. He taught all free.
One Mr. Austin (a most ingeniose man) was his scholar, and
yed so much that he became mad, fell a laughing, and so dyed, to
the great griefe of the old Gentleman. Mr. Stokes, another
lar, fell mad, and dream't that the good old Gentleman came ? schol-
im, and gave him good advice, and so he recovered, and is ? to him
l well.
He could not endure to see a Scholar write an ill hand; he
nt them all presently to mend their hands. Amongst others
Thomas Henshawe, who when he came to him wrote a lamentable hand
, he taught to write very well. He wrote a very elegant hand,
drew his Schemes most neatly, as they had been cut in copper.
father (no doubt) was an ingeniose artist at the Pen and ? this
nt him to write so well. taught
He was an Astrologer, and very lucky in giving his Judgements
ativities; he confessed that he was not satisfied how it came
t that one might foretell by the Starres, but so it was that
fell out true as he did often by his experience find; he did
eve that some genius or spirit did help.
The Countrey people did beleeve that he could conjure, and
like enough that he might be well enough contented to have them
thinke so.

He has told Bishop Ward, and Mr. Elias Ashmole (who was his
neighbour) that on this spott of ground (or leaning against this
Oake, or that ashe) the Solution of such or such a Probleme came
into my head, as if infused by a Divine Genius. after I had
thought on it without Successe for a yeare, two, or three.

Ben Oughtred told me that he had heard his father say to Mr.
Allen (the famous Mathematicall Instrument-maker) in his shop,
that he had found out the Longitude: sed vix credo (but I
scarcely believe it).

I have heard Mr. Hobbes say, and very truely, that with all
his great skill in Algebra, he did never add one Proposition to
Geometrie: he could bind up a Bundle well.

He was a great lover of Chymistry, which he studyed before
his son Ben can remember, and continued it; and told John Evelyn
of Detford, Esq., R.S.S., not above a yeare before he dyed, that
if he were but five yeares (or three yeares) younger, he doubted
not to find out the Philosopher's stone. It was made of the
harshest cleare water that he could gett, which he lett stand to
putrify, and evaporated by cimmering.

His wife was a penurious woman, and would not allow him to
burne candle after Supper, by which meanes many a good notion is
lost, and many a Probleme unsolved; so that Mr. Henshawe, when he
was there, bought candle, which was a great comfort to the old
man.

The right honourable Thomas Howard, Earle of Arundel and Sur
Lord High Marshall of England, was his great Patron, and loved
him intirely. One time they were like to have been killed toget
by the fall at Albury of a grott, which fell downe but just as t
were come out. My Lord had many Grotts about his house, cutt in
the Sandy sides of hills, wherin he delighted to sitt and discou

In the time of the Civill Warres the Duke of Florence invite
him over, and offered him 500 pounds per annum; but he would not
accept of it, because of his religion.

Notwithstanding all that has been sayd of this excellent man
he was in danger to have been Sequestred, and one Onslowe that w
was a great Stickler against the Royalists and a Member of the House
of Commons and living not far from him - he translated his Clavi
into English and dedicated it to him to clawe with him, and it d
? did doe his businesse and saved him from Sequestration.

I have heard his neighbour Ministers say that he was a pitti
Preacher; the reason was because he never studyed it, but bent a
his thoughts on the Mathematiques; but when he was in danger of
being Sequestred for a Royalist, he fell to the study of divinity

William Oughtred

Mr Oughtred: Mr Sloper tells me that his father was butler of Eton College: he remembers him, a very old man.

William Oughtred: see Henry Coley's *Astrologie*. -- A note from my honoured and learned friend Thomas Fludd esquire, who had been High Sheriff of Kent, to the effect that he was Mr Oughtred's acquaintance. He told me that Mr Oughtred confessed to him that he was not satisfied how it came about that one might foretell by the stars, but so it was that it fell out true as he did often by his experience find.

Mr William Oughtred, BD, Cambridge, was born at Eton in Buckinghamshire near Windsor, 5 March 1574.

His father taught to write at Eton, and was a scrivener, and understood common arithmetic, and 'twas no small help and furtherance to his son to be instructed in it when a schoolboy. His grandfather came from the north for killing a man. The last knight of the family was one Sir Jeffrey Oughtred. I think a Northumberland family (enquire).

He was chosen to be one of the King's Scholars at Eton College. He went to King's College in Cambridge at the age of 23, he wrote there his *Horologiographia Geometrica*, as appears by the title page.

He was instituted and inducted into the rectory or parsonage of Albury in Surrey, worth £100 per annum; he was pastor of this place fifty years.

He married Miss Caryl (an ancient family in those parts) by whom he had nine sons (most lived to be men) and four daughters. None of his sons he could make scholars.

He was a little man, had black hair, and black eyes (with a great deal of spirit). His head was always working: he would draw lines and diagrams in the dust.

His oldest son Benjamin (who lives in the house with my cousin Boothby (who gives him his board and now an old man) he bound apprentice to a watchmaker; who did work pretty well, but his sight now fails for that fine work. He told me that his father did use to lie abed till eleven or twelve o'clock, with his doublet on, ever since he can remember. Studied late at night, went not to bed till eleven o'clock, had his tinder box by him, and on the top of his bedpost he had his inkhorn fixed. He slept but little. Sometimes he went not to bed in two or three nights, and would not come down to meals till he had found out what he sought.

He was more famous abroad for his learning, and more esteemed, than at home. Several great mathematicians came over into England on purpose to converse with him. His country neighbours (though they understood not his worth) knew that there must be extraordinary worth in him, that he was so visited by foreigners.

When Mr Seth Ward, MA, and Mr Charles Scarborough, MD, came (as in pilgrimage, to see him and admire him) -- they lay at the inn at Shere (the next parish) -- Mr Oughtred had against their coming prepared a good dinner, and also he had dressed himself thus: an old red russet cloth cassock that had been black in days of yore, girt with an old leather girdle, an old fashioned russet hat, that had been a beaver [hat] in the days of Queen Elizabeth. When learned foreigners came and saw how privately he lived, they did admire and bless themselves, that a person of so much worth and learning should not be better provided for.

Seth Ward, MA, a fellow of Sidney Sussex College in Cambridge (now Bishop of Salisbury) came to him and lived with him half a year (and he would not take a farthing for his board) and learned all his mathematics of him. Sir Jonas Moore was with him a good while, and learned; he was but an ordinary accountant before Sir Charles Scarborough was his scholar; so Dr John Wallis was his scholar; so was Christopher Wren his scholar; so was Mr Smethwick, FRS. One Mr Austin (a most ingenious man) was his scholar, and studied so much that he became mad, fell a-laughing, and so died, to the great grief of the old gentleman. Mr Stokes, another scholar, fell mad, and dreamed that the good old gentleman came to him and gave him good advice, and so he recovered, and is still well. Mr Thomas Henshawe, FRS, was his scholar, then a young gentleman. But he did not so much like any, as those that tugged and took pains to work out, questions He taught all free. He could not endure to see a scholar write an ill hand; he taught them all at once to mend their handwriting Amongst others Mr T. Henshawe who when he came to him wrote a

lamentable hand, he taught to write very well. He wrote a very elegant'hand, and drew his schemes most neatly, as if they had been cut in copper. His father (no doubt) was an ingenious artist at the pen and taught him to write so well.

He was an astrologer, and very lucky in giving his judgements on nativities; he would say that he did not understand the reason why it should be so: but so it would,happen: he did believe some genius or spirit did. help. He has asserted the rational way of dividing the twelve houses according to the old way, which (the original) Elias Ashmole has of his own handwriting; which transcribe. Captain George Wharton has inserted it in his Almanac, 1658 or 1659 The country people did believe that he could conjure, and 'tis like enough that he might be well enough contented to have them think so. I have seen some notes of his own handwriting on Cattan's *Geomancy*.

He has told Bishop Ward, and Mr Elias Ashmole (who was his neighbour) 'on this spot of ground' or 'leaning against this oak' or 'that ash, the solution of such or such a problem came into my head, as if infused by a divine genius, after I had thought on it without success for a year, two or three'. Ben Oughtred told me that he had heard his father say to Mr Allen (the famous mathematical instrument maker) in his shop,,that he had found out the longitude; but I scarcely believe it.

Nicholas Mercator, of Holstein went to see him few years before he died. 'Twas about midsummer, and the weather was very hot, and the old gentleman had a good fire, and used Mr Mercator with much humanity (being exceedingly taken with his excellent mathematical wit) and one piece of his courtesy was to be mighty importunate with hi tn to sit on his upper hand next the fire; he being cold (with age) thought Mercator had been so too.

He was a great lover of chemistry, which he studied before his son Ben can remember, and continued it, and told John Evelyn of Deptford, FRS, not above a year before he died, that if he were but five years (or three years) younger, he doubted not to find out the philosopher's stone. He used to talk much of the maiden-earth for the philosopher's stone. It was made of the harshest clear water that he could get, which he let stand to putrify, and evaporated by simmering. Ben tended his furnaces. He has told me that his father would sometimes say that he could make the stone. Quicksilver refined and strained, and gold as it came natural over ...

The old gentleman was a great lover of heraldry, and was well known with the heralds, at their office, who proved his descent.

Memorandum: he struck out above half of the grammar and wrote new instead. He taught a gentleman in half a year to understand Latin, at Mr Duncombe's, his parishioner. Ask his daughter Mrs Brookes at Oxford for it.

His wife was a penurious woman, and would not allow him to burn candle after supper, by which means many a good notion is lost. and many a problem solved; so that Mr Henshawe, when he was there, bought candle, which was a great comfort to the old man.

The right honourable Thomas Howard, Earl of Arundel and Surrey, Lord High Marshal of England. was his great patron. and loved him entirely. One time they were likely to have been killed together by the fall at Albury of a grotto, which fell down but just as they were come out. My lord had many grottos about his house, cut in the sandy sides of hills. wherein he delighted to sit and discourse.

In the time of the Civil Wars the Duk e of Florence invited him over, and offered him £500 per annum; but he would not accept of it, because of his religion. For notwithstanding all that has been said of this excellent man, he was in danger to have been ejected from his living, and Onslow, that was a great stickler against the royalists and living not far from him -- he translated his Clavis into English and dedicated it to him to gain favour with him, and it did so his business and saved him from sequestration. Now this Onslow was no scholar and hated by the county, for bringing his countrymen of Surrey into the trap of slaughter when so many petitioners were killed at Westminster and on the roads in pursuit.

I have heard his neighbour ministers say that he was a pitiful preacher; the reason was because he never studied it, but bent all his thoughts on the mathematics; but when he was in danger of being sequestered for a royalist, he fell to the study of divinity. and preached (they said) admirably well, even in his old age.

He was a good Latinist and Grecian, as appears in a little treatise of his against one Delamain, a joiner, who was so

saucy as to write against him (I think about his circles of proportion): upon which occasion I remember I have seen. many years since, twenty or more good verses made, which begin to this purpose:

> Thus may some mason or rude carpenter
> Put into the balance his rule and compasses
> 'Gainst learned Euclid's pen etc.

Enquire for them and insert them.

Before he died he burned a world of papers, and said that the world was not worthy of them; he was so proud. He burned also several printed books, and would not stir, till they were consumed. His son Ben was confident he understood magic. Mr Oughtred, at the Custom House (his grandson), has some of his papers; I myself have his Pitiscus, embellished with his excellent marginal notes, which I esteem as a great rarity. I wish I could also have got his Billingsley's *Euclid*, which John Collins says was full of his annotations.

He died 13 June 1660 in the year of his age eighty-eight and odd days. Ralph Greatorex his great friend, the mathematical instrument maker, said he conceived he died with joy for the coming in of the king which was the twenty-ninth of May before. 'And are you sure he is restored? Then give me a glass of sack to drink his sacred majesty's health': his spirits were then quite upon the wing to fly away. The fifteenth of June he was buried in the chancel at Albury, on the north side near the screen between the chancel and the body of the church. I had much ado to find the very place where the bones of this learned and good man lay (and 'twas but sixteen years after his death). When I first asked his son Ben, he told me that truly the great grief for his father's death was so great, that he did not remember the place: now I should have thought it would have made him remember it the better: but when he had put on his considering cap (which was never like his father's), he told as aforesaid, with which others did agree: there is not to this day any manner of memorial for him, which is a great pity. I have desired for Mr John Evelyn etc, to speak to our patron, the Duke of Norfolk, to bestow a decent inscription of marble on him, which will also perpetuate his grace's fame. I asked Ben concerning the report of his father's dying a Roman Catholic: he told me that 'twas true indeed that when he was sick some priests came from my lord duke's (then Mr Henry Howard, of Norfolk) to him to have discourse with him, in order to his conversion to their church, but his father was then past understanding. Ben was then by, he told me.

He wrote a little treatise of watchmaking for the use of his son Benjamin, who told me that Mr Horton of Whitehall, of the Woodyard, has the true copy of it.

I have heard Mr Hobbes say (and very truly) that with all his great skill in algebra, he did never add one proposition to geometry; he could bind up a bundle well.

From John Aubrey's *Brief Lives*. (Edited by R Barber, Boydell Press, 1982)

John Aubrey (1626 - 1695) made a collection of notes, anecdotes and gossip about his contemporaries which are gathered together under the title Brief Lives. He was friendly with many of the English scientists of the day including many of the earliest members of the Royal Society.

William Oughtred

Mr Oughtred: Mr Sloper tells me that his father was butler of Eton College: he remembers him, a very old man.

William Oughtred: see Henry Coley's *Astrologie*. -- A note from my honoured and learned friend Thomas Fludd esquire, who had been High Sheriff of Kent, to the effect that he was Mr Oughtred's acquaintance. He told me that Mr Oughtred confessed to him that he was not satisfied how it came about that one might foretell by the stars, but so it was that it fell out true as he did often by his experience find.

Mr William Oughtred, BD, Cambridge, was born at Eton in Buckinghamshire near Windsor, 5 March 1574.

His father taught to write at Eton, and was a scrivener, and understood common arithmetic, and 'twas no small help and furtherance to his son to be instructed in it when a schoolboy. His grandfather came from the north for killing a man. The last knight of the family was one Sir Jeffrey Oughtred. I think a Northumberland family (enquire).

He was chosen to be one of the King's Scholars at Eton College. He went to King's College in Cambridge at the age of 23, he wrote there his *Horologiographia Geometrica*, as appears by the title page.

He was instituted and inducted into the rectory or parsonage of Albury in Surrey, worth pounds100 per annum; he was pastor of this place fifty years.

He married Miss Caryl (an ancient family in those parts) by whom he had nine sons (most lived to be men) and four daughters. None of his sons he could make scholars.

He was a little man, had black hair, and black eyes (with a great deal of spirit). His head was always working: he would draw lines and diagrams in the dust.

to drive the hands of a clock, were not uncommon in the 17th century. However, Phillip Hahn's mechanical equinoctial sundial (see Fig. 13), incorporating the analemma as a means of correcting for the equation of time, would seem to be the first of its kind that may be truly described as a *heliochronometer*. The use of the *analemma*, as a device for applying this correction directly to a sundial, at the time when Phillip Hahn first constructed such an instrument, would, no doubt, have been common knowledge in German sundial-making circles. What may seem somewhat surprising, however, is that the heliochronometer did not first make its appearance in France!

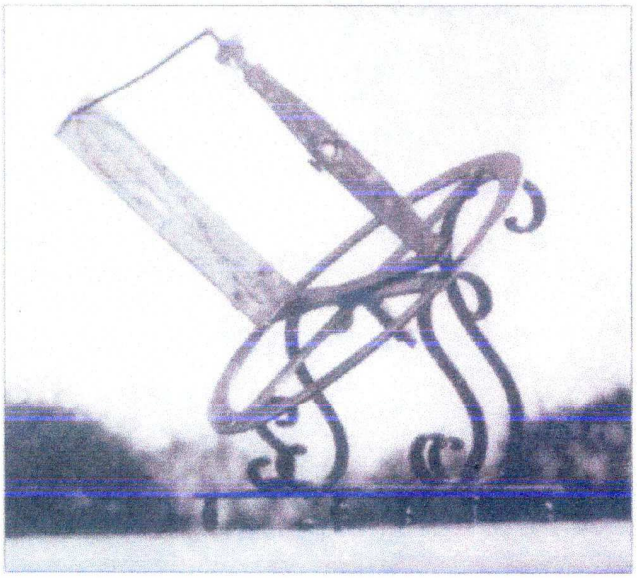

Fig. 14. The heliochronometer invented by L'Abbé Guyoux in about 1827. (after Charles Pommier, L'Astronomie.[43])

In about the year 1826 or 1827, L'Abbé Jean-Marie Victor Guyoux (1793-1869) invented what must be one of the simplest of all heliochronometers.[40,41] Shown in Fig. 14, it comprises a basic rectangular frame, constructed as an alidade or sighting arm, fitted with two tall perpendicular vanes, one containing a small circular aperture at its centre, through which the sun's rays may pass to project a spot of light onto the other vane, the latter being engraved with the equation of time curve in the form of the analemma. This sighting arm is pivoted on the equinoctial hour-ring of the sundial, which, in turn, is mounted on a simple supporting frame, manufactured specifically for the latitude of the particular site. Thus, the sighting arm may be turned, until the projected spot of light coincides with the date on the analemma, when the correct 'clock' time will be indicated by a pointer on the equinoctial hour-scale. Whilst alidades of various forms, fitted to equinoctial sundials, were in common use in the 16th century, as illustrated, for example in the works of Clavius,[42] it is quite probable that L'Abbé Guyoux conceived the idea for his instrument from the system devised by Phillip Hahn.[43] Nevertheless, much to his credit, Guyoux's heliochronometer won commercial medals of honour in 1841 and in 1855. It is understood that a number of these sundials may still be found today in the gardens of some of the more historic properties of France. Furthermore, his instrument may well have been the inspiration for the elegant and sophisticated, but similar 'universal' heliochronometer, first made in 1860 by M. Fléchet, an engineer in Paris.[44] Fléchet's heliochronometer, shown in Fig. 15, was an instrument of great precision, which was used by the French railways in the late 19th and early 20th centuries, to regulate their station clocks and to ensure that their trains ran on time. The earliest illustration of it in an English publication, of which I know, is that which appeared in a little book on popular astronomy in 1882.[45]

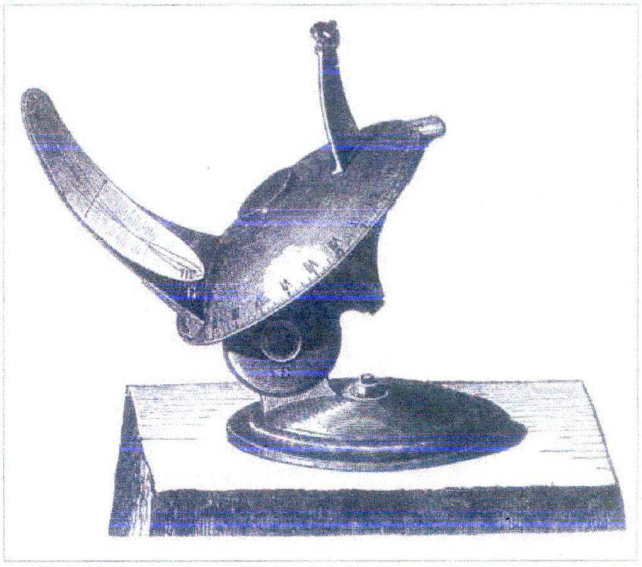

Fig. 15. Fléchet's elegant heliochronometer, first made in 1860 and used by the French railways to regulate their clocks.

THE HELIOCHRONOMETER IN ENGLAND AND SCOTLAND

In England, in the tradition of the English *Art of Dialling*, the heliochronometer was invented independently, without any evident knowledge of the analemma, by George J. Gibbs, just before the turn of the 19th century, and was patented in 1906. Shown in Fig. 16, it was manufactured by Messrs Pilkington & Gibbs of Preston and was much in demand, being exported to many countries around the world. This magnificent instrument had the usual sighting vanes, but its ingenuity lay in the hidden cam, beneath the date-setting disc on the equinoctial dial-plate, which allowed for the equation of time correction when the instrument was set for the particular date, by adjusting one of the sighting vanes.[46] At about the same time, William M.

dial.[37,38] It is shown in Fig. 10 and is a somewhat cumbersome instrument in appearance, comprising a heavy brass meridian ring, graduated with a 90-degree 'latitude' scale in one quadrant, suspended from a curved supporting arm, which may be turned in azimuth about a graduated circular plate, fixed to a heavy wooden base. The meridian ring, which may be set for the latitude of the place of observation by use of the graduated scale, is furnished with a fixed steel rod, passing through its centre and lying in the polar axis of the instrument. Within this assembly, a rectangular frame, fitted with a plate at each end, may be rotated about the steel rod, in the plane of the equinoctial. One of these plates is pierced by two small circular apertures or 'pin-holes', as a *nodus*, such that when the rectangular frame is aligned with the sun, two spots of light will be projected onto the opposite plate, engraved with a zodiacal declination scale and with an equation of time correction curve, in the form of the *analemma*. Since the rectangular frame is geared to drive the hands attached to a clock, when the two spots of light are projected, so as to be aligned with the declination for the date in question, on the scale of zodiacal signs, and also to coincide with the appropriate point on the analemma, the correct time will be shown by the clock.

Instruments of this kind, developed from the self-orienting dial seen in Fig. 11 and ascribed to the brilliant English mathematician William Oughtred (1575-1660) (Fig. 12), the universal equinoctial ring dial,[39] with an alidade and pin-hole sights or a combination of lenses, fitted with gears

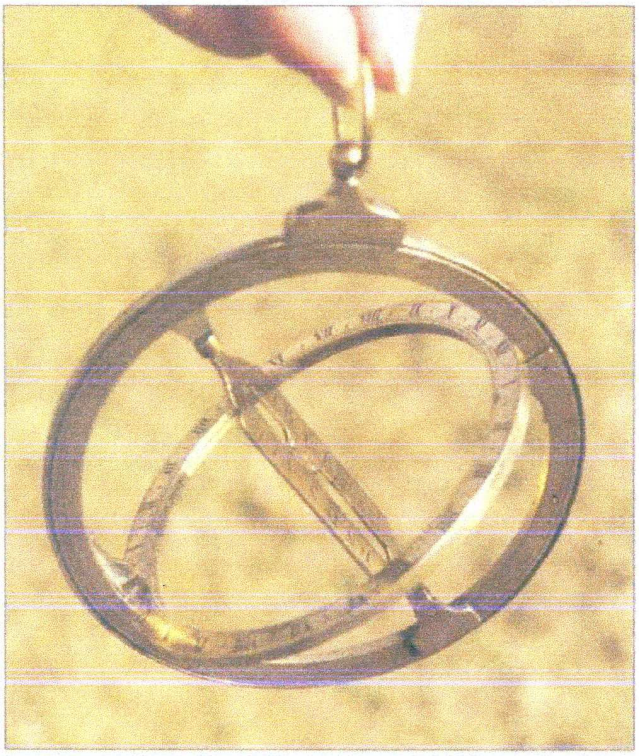

Fig. 11. An 18th century universal equinoctial ring-dial, in use.

Fig. 12. William Oughtred, the brilliant English mathematician, who invented the universal equinoctial ring-dial.

Fig. 13. Early 17th century mechanical equinoctial sundial in the National Maritime Museum at Greenwich. (NMM.)

THE OUGHTRED SOCIETY

DEDICATED TO THE PRESERVATION AND HISTORY OF SLIDE RULES AND OTHER CALCULATING INSTRUMENTS

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Slide Rule History

Prologue

In the 16th Century, engineering design as we know it today, with its emphasis on precise measurements and finely calculated tolerances, is unthinkable. And yet, every scientist, mathematician and alchemist feels that there are basic fundamental mathematical relationships that underpin the natural world.

The pre-eminent figures in science both contribute to the creation of the slide rule and make use of it in their work, including Galileo, Napier, Gunter, Oughtred, Newton, Gauss, Watt, Priestley, Fulton, Fuller, Einstein, Fermi, and Von Braun.

A quick look at the first five of these men covers the creation and initial evolution of the slide rule.

Just Before the Slide Rule

Galileo Galilei popularizes the sector at the very end of the 16th Century. The sector is a graduated ruler that uses trigonometric formulae and a caliper to calculate squares, cubes, reciprocals and tangents of numbers. Galileo's design of the sector as a mathematical tool can be seen as the moment when calculation aids cease to be based upon counting and instead exploit the deeper relationships among numbers. His invention is still in use as a navigation aid in the 20th century ... 300 years later.

John Napier dramatically advances the understanding of number relationships in 1614 with his invention of logarithms. Since logarithms are the foundation on which the slide rule is built, its history rightly begins with him. His early concept of simplifying mathematical calculations through logarithms makes possible the slide rule as we know it today.

Chronology of the Slide Rule

Napier himself contributes Napier's Bones in 1617, calculating sticks based on the gelosia, or lattice, multiplication method. In 1620 Edmund Gunter of London makes a straight logarithmic scale and performs multiplication and division on it with the use of a set of dividers, or calipers.

In about 1622 William Oughtred, an Anglican minister ... today recognized as the inventor of the slide rule ... places two such scales side by side and slides them to read the distance relationships, thus multiplying and dividing directly. He also

develops a circular slide rule.

In 1675 Sir Isaac Newton solves cubic equations using three parallel logarithmic scales and makes the first suggestion toward the use of the cursor.

In 1677, two years after Newton invents the cursor, Henry Coggeshall perfects the timber and carpenter's rule. Newton's cursor fails to catch on at the time. The Coggeshall rule remains in common use 200 years later. His design and its standardization move the slide rule from a tool of mathematical inquiry to specialized applications. Beginning in 1683, Thomas Everard popularizes the gauging rule, used to determine the content of ale, wine and spirits barrels and to calculate the excise tax thereon. This design, first created by William Oughtred in 1633, sees widespread use well into the 19th century.

In 1722 John Warner, a London instrument dealer, uses square and cube scales. By 1790 James Boulton and James Watt are modifying slide rules to improve their accuracy and usefulness. By 1799 their Soho slide rule helps to usher in the Industrial Revolution. It facilitates the design and manufacture of their seminal machine, the steam engine.

In 1815 Peter Roget, an English physician (and the author of Roget's Thesaurus), invents a log log scale, which he uses to calculate roots and powers to any number or fraction thereof. It is regarded at the time as a mathematical curiosity. Fifty years later, advances in electrical engineering, thermodynamics, dynamics and statics, and industrial chemistry make these scales so necessary they are rediscovered. In the next fifty years they increase from three, to six, to eight scales on the slide rule, as engineering extends its grip on modern computation.

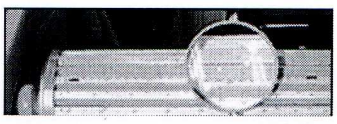
In 1851 a French artillery officer named Amedee Mannheim standardizes a set of four scales for the most common calculation problems. The four scales include two double length, named A & B, for squares and square roots ... and two single length, C & D, for multiplication and division. This scale set becomes the basis of slide rule design for the next 100 years and bears his name today. His design and use of a cursor hastens the eventual widespread acceptance of this feature.

Early in the 19th century the first slide rules come into use in the United States. Ex- president Thomas Jefferson has one, and Joseph Priestley recognizes their advantages in his chemistry work, which includes the discovery of oxygen.

By 1870, Germany produces two giants of the slide rule world, Dennert and Pape (makers of Aristo), and Faber (later Faber-Castell). The Dennert and Pape contributions of "engine divided" (engraved) scales and the stable deposit of celluloid on wood are revolutionary.

The slide rule's importance to the Industrial Revolution, and the impact of the Industrial Revolution upon the slide rule, are demonstrated by the proliferation of designs. From 1625 to 1800, the first 175 years after its invention, a total of 40 slide rule types, including circular and spiral designs, are recorded. The next 100 years, from 1800 to 1899, sees the creation of 250 slide rule types and manufacturers. Over 90 designs are recorded in the first 10 years of the 20th Century.

Cylindrical calculators with extra long logarithmic scales are invented by George Fuller of Ireland in 1878 and Edwin



Thacher of New York in 1881. Production of Thacher's calculator is soon taken over by a Hoboken, New Jersey instruments company, Keuffel and Esser, which had previously imported slide rules for sale.

A revolutionary linear slide rule construction with scales on both front and back and with a cursor referring to all scales simultaneously is patented in 1891 by William Cox ... an invention he calls the "duplex slide rule". It is sold by K&E.

Folded scales CF, DF and CIF are put on slide rules about 1900 to reduce the amount of movement and resetting of the slide.

Log log scales in three sections appear about 1901, enabling very accurate calculation of powers and roots to any number or fraction.

The Slide Rule's Last Century ... the 20th

Our last century could not have been built without the slide rule, yet its direct evidence is almost totally missing to the uninformed eye.

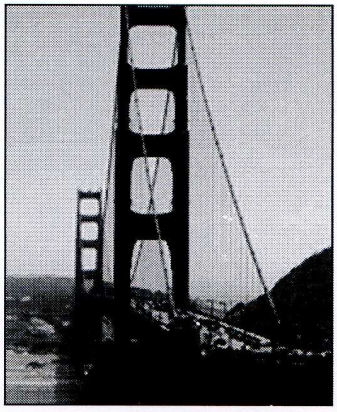
In the United States, this indispensability is seized upon most successfully by Keuffel and Esser. This firm moves from importing rules in the 1870s, to building a complex calculating instrument (the Thacher Calculator) in the 1880s, to manufacturing their own slide rules in the 1890s. Their contributions are legion, including the CI scale, their fanatical devotion to precision, their use of colored scales and slanting italics to aid in reading direction.

A different path to market dominance is adopted in Japan by Jiro Hemmi. Hemmi systematically experiments with both natural base materials and celluloid, settling upon bamboo as the core, and combining this with very modern manufacturing (including celluloid surface lamination), resulting in both high quality and quantity. In the 1960's Hemmi is producing one million slide rules annually.

Epilogue

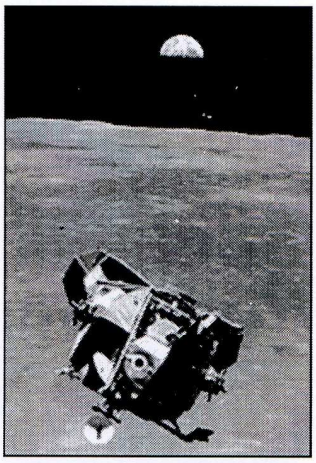
The philosophy of engineering moves on. And the triumphs of 20th Century design become limitations for the slide rule.

Einstein favors a Nestler slide rule in his work. The approaches to the Golden Gate Bridge and the thrust profile of the Redstone Rocket are designed with simple Rietz based slide rules ... E. H. Lowry's Dietzgen Phillips 1725 and Wernher Von Braun's Nestler 23 respectively. Pickett slide rules provide emergency computational power aboard Apollo missions with their N600-ES model. The Pickett N3 and N4 take their places along with the K&E Decilon and the Post Versalog in designing the F16 fighter airplane.



But structural design and first principles in physics both seek answers to how structures will react to changing loads and forces. Wind speeds, tidal friction and interstellar collision all require dynamic computational models, rather than the answer to a static structural problem. Large, slow, obese computing engines designed for these questions give birth

to the sleek four-function calculator. K&E's travails with its Analon slide rule model are an excellent example of the change in engineering demands that surpassed the slide rule. The four function electronic calculator is a symptom as much as a cause of this change.



Slide rule researchers have estimated that possibly 40 million slide rules were produced in the world in the 20th century alone. Among these are many types of specialty slide rules developed and made for specific applications such as chemistry, surveying, electricity and electronics, artillery ranging, hydraulics, steam and internal combustion engines, concrete and steel structures, radio and other special fields.

The slide rule has a long and distinguished ancestry ... from William Oughtred in 1622 to the Apollo missions to the moon ... a span of three and a half centuries ... it was used to perform design calculations for virtually all the major structures built on this earth during that long period of our history ... an amazing legacy for something so mechanically simple.

THE OUGHTRED SOCIETY

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About this site.
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last modified January 24, 2006

William Oughtred

Born: 5 March 1574 in Eton, Buckinghamshire, England
Died: 30 June 1660 in Albury, Surrey, England

William Oughtred attended Eton School, which although a very famous school was in fact his local school. From there he went to King's College Cambridge, entering in 1592. Three years later he became a Fellow of King's College, received his B.A. in 1596 and his M.A. in the year 1600. It is surprising that although very little mathematics was taught at either Eton or Cambridge at this time Oughtred became passionately interested. He wrote:-

> *... the time which over and above those usuall studies I employed upon the mathematicall sciences I redeemed night by night from my naturall sleep, defrauding my body, and inuring it to watching, cold, and labour, while most others tooke their rest.*

Oughtred was ordained an Episcopal minister in 1603. In 1604 he became vicar of Shalford and later, in 1610, he became rector of Albury.

Oughtred took private pupils who came to his house and lived there free of charge while they received mathematical instruction. He had many pupils but the most famous were John Wallis, Christopher Wren and Richard Delamain.

Aubrey [4] gives an interesting description of Oughtred's appearance and lifestyle:-

> *He was a little man, had black haire, and blacke eies (with a great deal of spirit). His head was always working. He would draw lines and diagrams on the dust.... he used to lye a bed till eleaven or twelve a clock, with his doublet on ... studyed late at night, went not to bed till* 11 *a clock, had his tinder box by him, and on top of his bed-staffe, he had his inke-horne fixed. He slept but little. Sometimes he went not to bed in two or three nights, and would not come downe to meales till he had found out the quaesitum.*

Oughtred's most important work, *Clavis Mathematicae* (1631), included a description of Hindu-Arabic notation and decimal fractions and a considerable section on algebra. He experimented with many new symbols including $\times$ for multiplication and :: for proportion. Like all Oughtred's works it was very condensed containing only 88 pages.

Oughtred used π in *Clavis Mathematicae* but not for the ratio of the circumference to the diameter, merely for the circumference. Other notation for greater than and less than proved hard to remember and were not accepted, the familiar > and < being due to Harriot at almost the same time.

Oughtred is best known for his invention of an early form of the slide rule. Edmund Gunter (1620) plotted a logarithmic scale along a single straight two foot long ruler. He added and subtracted lengths by using a pair of dividers, operations that were equivalent to multiplying and dividing. In 1630 Oughtred invented a circular slide rule. In 1632 he used two Gunter rulers so that he could do away with the dividers. He published *Circles of Proportion and the Horizontal Instrument* in 1632 describing slide rules and sundials.

There was a dispute however regarding priority over the invention of the circular slide rule. Delamain certainly published a description of a circular slide rule before Oughtred. His *Grammelogia, or the Mathematicall ring* was published in 1630. It may well be that both invented this instrument independently. Unfortunately a very heated argument ensued and to some extent this formed a cloud over the later years of Oughtred's life.

The present form of the slide rule was designed in 1850 by a French army officer, Amedee Mannheim.

Oughtred's other works were *Trigonometrie* (1657), one of the first works on trigonometry to use concise symbolism, and a number of more minor works on watchmaking, solving spherical triangles by the planisphere and methods to

determine the position of the sun.

Article by: *J J O'Connor* and *E F Robertson*

December 1996

MacTutor History of Mathematics
[http://www-history.mcs.st-andrews.ac.uk/Biographies/Oughtred.html]