

WILLIAM OUGHTRED (March 5, 1574 – June 13, 1660)

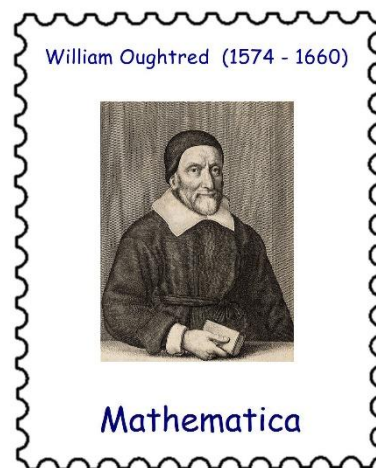
by HEINZ KLAUS STRICK , Germany

Many of the symbols we use today in algebra came into use in the 16th and 17th centuries.

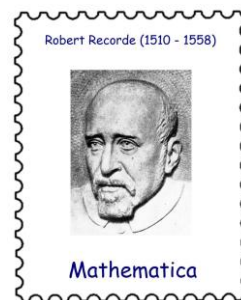
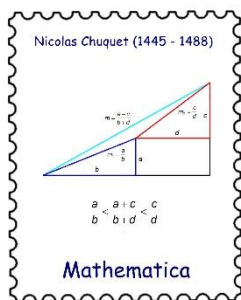
In 1484 NICOLAS CHUQUET had used the symbols p and m for addition and subtraction. These were also used by other mathematicians, for example by GIROLAMO CARDANO in his *Ars magna* (1545). In the end, however, the symbols $+$ and $-$ proposed by the German *Cossist* JOHANNES WIDMANN in 1489 became standard.

In 1631, WILLIAM OUGHTRED invented the symbol \times for multiplication, which is still in use today but is usually replaced by the simple dot (introduced in 1693 by GOTTFRIED WILHELM LEIBNIZ).

The symbol $=$ for the equality of numbers or terms was adopted in 1556 by ROBERT RECORDE.

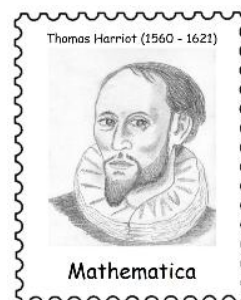
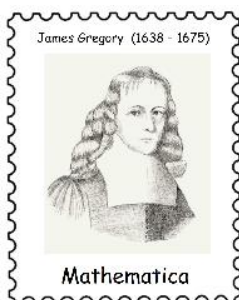
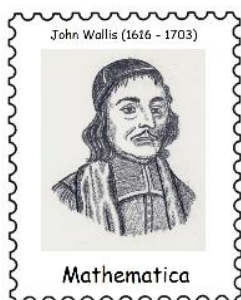


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Much of the impetus came from the English mathematician WILLIAM OUGHTRED, mentioned above. He was a great admirer of the Greek mathematicians EUCLID, ARCHIMEDES, APOLLONIUS and DIOPHANTUS. However, he was troubled by the fact that their writings were difficult to read, as everything was described in words. He judged that mathematical theorems would be easier to read and remember if symbols were used.

Although OUGHTRED's symbol $::$ for the proportionality of two quantities was also adopted by JOHN WALLIS in Oxford and JAMES GREGORY in Edinburgh, it did not ultimately gain widespread acceptance. Furthermore, THOMAS HARRIOT's relational symbols $>$ and $<$ proved to be more popular than the symbols \sqsupset and \sqsubset proposed by OUGHTRED.



In trigonometry OUGHTRED introduced the abbreviations sin, tan and sec, which are still in use today. He also coined the notation \pm .

WILLIAM OUGHTRED was born in Eton, Berkshire. His father, BENJAMIN, worked as a writing teacher at *Eton College*. At the age of 13, the boy was admitted to the famous college as a *King's Scholar* (since the 15th century, the total number of scholars has been fixed at 14 per year). WILLIAM then moved to King's College, Cambridge and at the age of 21 he was appointed a Fellow. In 1596 he received his B.A. (*Baccalaureus Artium*), followed four years later by his M.A. (*Magister Artium*).

Throughout his studies, OUGHTRED showed great interest in mathematics, though this was not particularly encouraged at either Eton or Cambridge. The curriculum at the college was essentially limited to the classical mathematics of antiquity. The teachers paid no attention to the current developments in algebra in Italy, France and Germany, so the inquisitive OUGHTRED had to familiarise himself with the new algebra independently.

In 1603, OUGHTRED was ordained as a priest in the Church of England and in 1604, he was appointed vicar in Shalford (near Guildford, approximately 50 km from London). There he met his wife, CHRISTSGIFT CARYLL. Twelve children were born during the marriage.

In 1610, OUGHTRED took up a post as parish priest and rector in neighbouring Albury, which he held until the end of his life.

Despite having a large number of children of his own, OUGHTRED regularly took pupils into his home, whom he taught Latin and mathematics – without charge.

Even during his school and university years, OUGHTRED had taken an interest in the construction of astronomical instruments. In 1597 he wrote *An Easy Way of Delineating Sun-Dials by Geometry* which, however, did not appear in print until 1647. Prior to this, his pupil, CHRISTOPHER WREN — who later became famous as an architect — had published a Latin translation of the work.

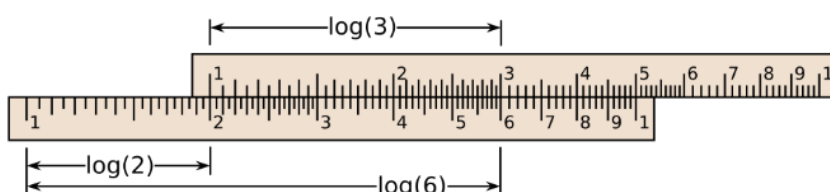


OUGHTRED was also friends with HENRY BRIGGS, who had been the first Professor of Mathematics at *Gresham College* in London since 1597 and, from 1619, was also the first *Savilian Professor* at *Merton College* in Oxford. It was through BRIGGS that OUGHTRED learnt of JOHN NAPIER's invention of logarithms



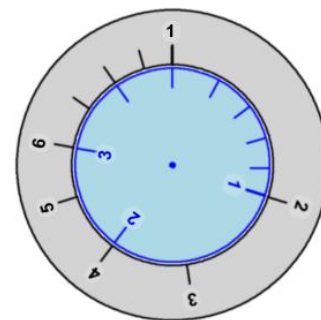
EDMUND GUNTER also taught at *Gresham College*. Like OUGHTRED, he was involved in the construction of measuring instruments for astronomy and geodesy. Among other things, *GUNTER's chain* is named after him. This consists of 100 pieces of wire of equal length, connected to one another in a movable manner by brass rings. This special measuring tape enabled length measurements to be carried out with great accuracy in the field.

Around 1620, GUNTER came up with the idea of marking a logarithmic scale on a measuring rod approximately 60 cm long (known as *GUNTER's rule*). Logarithms could be measured here using a divider and marked in such a way that multiplication or division was possible. However, this method was cumbersome and inaccurate. Then in 1632, OUGHTRED had the idea of using a second measuring rod with logarithmic markings instead of the divider, which could then be placed against the first and slid against it – the birth of the slide rule.



(graphic from Wikipedia / Jakob.Scholbach)

In 1631, an unpleasant dispute over priority arose with RICHARD DELAMAIN, formerly his pupil and subsequently a student of GUNTER. In his treatise *Grammologia or the Mathematical Ring*, DELAMAIN described how calculations could be performed using a ring-shaped slide rule.



OUGHTRED claimed that DELAMAIN had stolen the idea from him. In 1632, he published the treatise *The Circles of Proportion and the Horizontal Instrument*. In it, he also levelled serious methodological criticisms at DELAMAIN. Whilst he himself considered it essential to deal with the laws of logarithms in order to understand how the slide rule worked, DELAMAIN was content to use the instrument as a 'black box'.

Through his marriage to CHRISTSGIFT CARYLL, OUGHTRED came into contact with influential figures, including THOMAS HOWARD, 21st Earl of Arundel, whose son WILLIAM he tutored in mathematics. HOWARD offered him permanent accommodation in London, which OUGHTRED regularly used, among other things to stay in touch with an instrument maker who manufactured and sold the devices he designed. His hope that these close relationships might also be useful for his clerical career was not fulfilled.

Clavis Mathematicae originated from the lessons given to the Earl's son (its full title: *Arithmeticae in numeris et speciebus institutio: quae ... totius mathematicae quasi clavis est* – Foundation of Arithmetic in Numbers and Types, which is ... like a key to mathematics), which was first published in 1631, with six more editions following, as well as in English translation.

Starting with an explanation of the number system and arithmetic operations (including written multiplication and division), OUGHTRED introduced algebra using his own symbols and notation. The handling of combinations of prefixes and operation symbols was presented as a rule.

He denoted powers with letters (e.g., Aq for A^2 , Ac for A^3), and instead of the parentheses commonly used today, he employed colons (e.g., $Q: A - E:$ for $(A - E)^2$).

The work contained binomial formulas, including those for higher powers, an introduction to logarithms and their applications, the solution of quadratic equations, and the solution of geometric problems using algebraic methods.

OUGHTRED was the first to use the letter π in connection with the ratio of circumference to diameter (although he wrote $\frac{\pi}{\delta}$).

OUGHTRED was held in the highest esteem by English mathematicians. WALLIS, for example, dedicated his *Arithmetica infinitorum* to him in 1655. OUGHTRED wrote further works, including *Trigonometria* (1657) on the geometry of plane and spherical triangles, in which he consistently used further shorthand notations.

For the staunch royalist OUGHTRED, the Civil War, which ultimately led to the execution of King CHARLES I, was a difficult time. He was even summoned before OLIVER CROMWELL's Control Committee, but thanks to the testimony of some advocates, he was not removed from office (one witness called him: "*About this time, the most famous mathematician of all Europe*").

On his deathbed, he learned with joy that the old order had been restored with the new King CHARLES II.

