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(*b*. Bristol, England, 1786; *d*. Bath, England, 22 September 1837)

mathematics.

The son of William Horner, a Wesleyan minister, Horner was educated at the Kingswood School, Bristol, where he became an assistant master (stipend £40) at the age of fourteen. After four years he was promoted to headmaster, receiving an additional £10 annually. According to an account given by an "old scholar" in the *The History of Kingswood School… By Three Old Boys* [A. H. L. Hastings, W. A. Willis, W. P. Workman] (London, 1898), p. 88, the educational regime in his day was somewhat harsh. In 1809 Horner left Bristol to found his own school at Grosvenor Place, Bath, which he kept until his death. He left a widow and several children, one of whom, also named William, carried on the school.

Horner's only significant contribution to mathematics lay in the method of solving algebraic equations which still bears his name. Contained in a paper submitted to the Royal Society (read by Davies Gilbert on 1 July 1819), "A New Method of Solving Numerical Equations of All Orders by Continuous Approximation," it was published in the *Philosophical Transaction* (1819) and was subsequently republished in *Ladies' Diary* (1838) and *Mathematician* (1843). Horner found influential sponsors in J. R. Young of Belfast and Augustus de Morgan, who gave extracts and accounts of the method in their own publications. In consequence of the wide publicity it received, Horner's method spread rapidly in England but was little used elsewhere in Europe.

Throughout the nineteenth and early twentieth centuries Horner's method occupied a prominent place in standard English and American textbooks on the theory of equations, although, because of its lack of generality, it has found little favor with modern analysts. With the development of computer methods the subject has declined in importance, but some of Horner's techniques have been incorporated in courses in numerical analysis.

Briefly, when a real root of an equation has been isolated by any method, it may be calculated by any one of several arithmetical processes. A real root r, of $f(x) = 0$, is isolated when one finds two real numbers $a, b,$ between which r lies and between which lies no other root of $f(x) = 0$. Horner's method consists essentially of successively diminishing the root by the smaller members of successive pairs of positive real numbers.

If

and if $x = h + y$, we have (expanding by Taylor's theorem)

If this is written

the coefficients $c_n, c_{n-1}, c_{n-2},..., c_0$ in the reduced equation are given by the successive remainders when the given polynomial is divided by $(x – h), (x – h)^2, (x – h)^3,..., (x – h)^n$. In the original account of the method Horner used Arbogast's derivatives ($D\phi R$, $D^2\phi R,..., D^n\phi R$). Later he dispensed altogether with the calculus and gave an account of the method in entirely algebraic terms. Successive transformations were carried out in a compact arithmetic form, and the root obtained by a continuous process was correct to any number of places. The computational schema adopted is often referred to as synthetic division. Horner suggested, correctly, that his method could be applied to the extraction of square and cube roots; but his claims that it extended to irrational and transcendental equations were unfounded.

Although Horner's method was extremely practical for certain classes of equations, the essentials were by no means new; a similar method was developed by the Chinese in the thirteenth century (see J. Needham, *Science and Civilisation in China*, I [Cambridge, 1959], p. 42). The iterative method devised by Viète (1600) and developed extensively by Newton (1669), which came to be known as the Newton-Raphson method, is applicable also to logarithmic, trigonometric, and other equations. The numerical solution of equations was a popular subject in the early nineteenth century, and in 1804 a gold medal offered by the Società Italiana delle Scienze for an improved solution was won by Paolo Ruffini (… *Sopra la determinazione delle radici…* [Modena, 1804]). Ruffini's method was virtually the same as that developed independently by Horner some years later.

BIBLIOGRAPHY

I. Original Works. Horner's writings include "A New Method of Solving Numerical Equations of All Orders by Continuous Approximation," in *Philosophical Transactions of the Royal Society*, **109** (1819), 308–335; "Horae arithmeticae," in T. Leybourn, ed., *The Mathematical Repository*, V, pt. 2 (London, 1830); and "On Algebraic Transformations," in *Mathmatician* (1843).

II. Scondary Literature. Accounts of the method are given by J. R. Young in *An Elementary Treatise on Algebra* (London, 1826); and *The Theory and Solution of Algebraical Equations* (London, 1843). Augustus de Morgan described the method in sundry articles, including "On Involution and Evolution," in *The Penny Cyclopaedia*, vol. XIII (London, 1839); and "Notices of the Progress of the Problem of Evolution," in *The Companion to the Almanack* (London, 1839). See also Florian Cajori, "Horner's Method of Approximation Anticipated by Ruffini," in *Bulletin of the American Mathematical Society*, **17** (1911), 409–414.

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