

# Etymology of the word ‘sine’

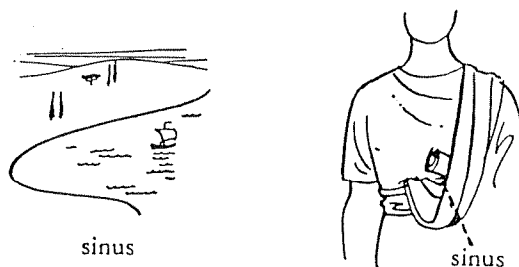
Trigonometry has its origin in the astronomy of the Babylonians of the third-century BC and was then taken up by the Greeks. The first trigonometric table was constructed by Hipparchus about 150 B.C., who is accordingly known as the father of trigonometry.<sup>1</sup> This was a table of lengths of chords subtended by arcs in a fixed circle, for this is the natural length to consider as corresponding to a given arc. While this table of Hipparchus has been lost, as has the table of Menelaus (c. A.D. 100), that of Ptolemy (A.D. 150) survives. It also is a table of chords. If you have any doubts about the astronomical roots of trigonometry you should remember that Ptolemy’s table is in the first chapter of his *Almagest*, a work on theoretical astronomy.

Chords may be the most natural length to compute, but mathematically they are not the most convenient to us. In problem after problem, there was a need to calculate half the chord of double the angle. This led astronomers to tabulate this quantity, which is our modern sine.<sup>2</sup>

The Hindu mathematician Āryabhata was dealing with half-chords by AD 500. He called these half-chords *ardha-jya* in Sanscrit and frequently abbreviated *jya* (chord). From this word the Arabs coined the technical term *jiba* meaning half-chord. Because of the fact that vowels were frequently omitted the abbreviation *jb* was misconstrued by later Arabic writers, who were also unaware of the fact that *jiba* was a neologism, as the word *jaib*, which contains the same consonants and means

“cave” or “bay.” [cf., Katz, p. 201]

Scholars in Europe in the twelfth century were fascinated by the work of the Arabs on algebra and trigonometry and so naturally were anxious to see translations into Latin. Around 1150 Robert of Chester and Gerardo of Cremona translated several trigonometrical works into Latin. They also confused the Arabic words *jiba* and *jaib* which they translated as *sinus*, the Latin word for the fold of a toga about the breast or for a hollow or gulf (your sinuses are those hollow places in your skull).<sup>3</sup>



This then is the origin of our word *sine*. It is due to the misunderstanding and mistranslation of

<sup>1</sup> Bartholomeo Pitiscus (1561-1613) coined the word “trigonometry,” meaning the measurement of triangles, 1595 in his *Trigonometria: sive de solutione triangulorum tractatus brevis et perspicuus*, revised as *Trigonometriae sive de dimensione triangulorum libri quinque* (1600). There is a 1614 English translation. Interestingly, it was in this work that trigonometry was first applied to the solution of triangles involving points on earth. Previously trigonometry was only used to solve spherical and plain triangles involving astronomy. See Victor Katz, *A History of Mathematics. An Introduction* (1993), p. 367.

<sup>2</sup> See Katz, pp. 140-142.

<sup>3</sup> These delightful illustrations are from Hans H. Oerberg, *Lingua Latina secundum naturae rationem explicata*, Naturmethodens Sproginstitut (The Nature Method Institutes): Copenhagen, four volumes, third edition 1965, pp. 708 and 759 (in the fourth volume, although the volumes are paginated continuously). I recommend these volumes as a superb way to learn Latin. They are completely in Latin except for the copyright notice and they commence with a simple, but well illustrated, story about a family and progress through the grammar and vocabulary in small steps (the only dictionary I used was an English dictionary that contained etymologies). I owe a great debt to Magister Boleslaus Povsic who, after the first year, spoke only Latin in class. It was a wonderful way to learn the language.

a technical term which was coined because Arabic had no word corresponding to the Hindu word for half-chord.

By happy accident the Latin meaning of fold or curve of a tunic took on a new meaning, but that took several centuries more. The first to sketch a sine curve was Giles Personne de Roberval in the seventeenth-century when computing the area under the cycloid, although he did not know what he had done. Thus begins the long process of abstraction from sines as lengths of half-chords to the sine as a function of an angle. This process culminated in the work of Euler in the eighteenth-century when he introduced the trigonometric ratios and the unit circle. It is only at this time that trigonometry takes on the form that is familiar to us today.

### The Other Trigonometric Functions

The terms 'umbra recta' and 'umbra versa' were introduced for the tangent and cotangent in the twelfth-century by Gerard of Cremona while translating work from Arabic to Latin ('umbra' is the Latin word for shadow). The words 'tangent' and 'secant' were coined by the physician and mathematician Thomas Finck of Basel in 1583 in his *Geometria rotundi*, and adopted by Pitiscus.<sup>4</sup>

It was also in the twelfth-century that what we call the cosine was given a special name. Pitiscus also used the term 'sinus complementi' (sine of the complement) and then in 1620 Edmund Gunter (1581-1626) abbreviated this as 'co. sinus.' In 1658, John Newton shortened this to 'cosinus.' Gunter also coined the word 'cotangent.'

The secant and cosecant were almost unknown before the sixteenth-century.<sup>5</sup>

### REMARK

There are many lessons to be learned from the history of trigonometry, but alas it is the least developed of all fields of elementary mathematics. The story told above varies in detail and emphasis from historian to historian and so should be understood as my interpretation of the facts. Suggestions for improvements would be welcomed.

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<sup>4</sup> Florian Cajori, *A History of Mathematics*, 1924, pp. 132 and 151.

<sup>5</sup> Vera Sanford (1891-1971), *A Short History of Mathematics* (1930), p. 298.