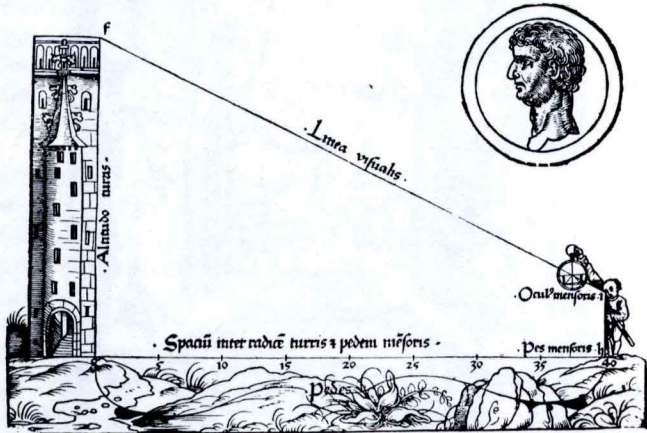
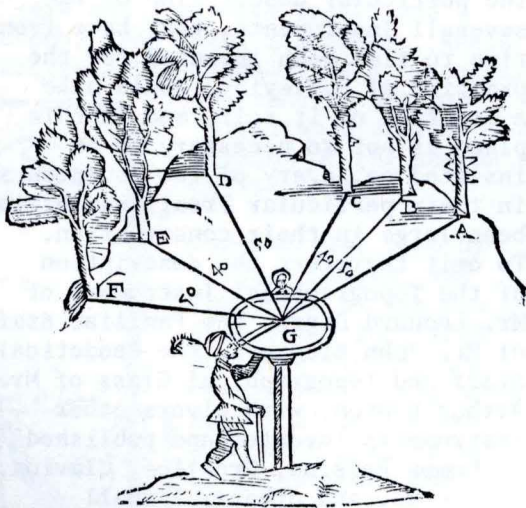


The Simple Theodolite

The astrolabe was the most commonly-used astronomical instrument of the Middle Ages. The front, with its planispheric representation of the heavens, was used for all manner of astronomical calculations. The reverse, designed for measuring stellar altitudes, carried a divided circle with a centrally-pivoted alidade with sights. It could also be used as a surveying instrument - vertically for measuring altitudes or horizontally for azimuths. The reverse also commonly had a double shadow square or geometric square.



The astrolabe used to measure height, from J. Dryander, *Annulorum trium diversi generis instrumentorum astronomicorum*, Marburg, 1532.

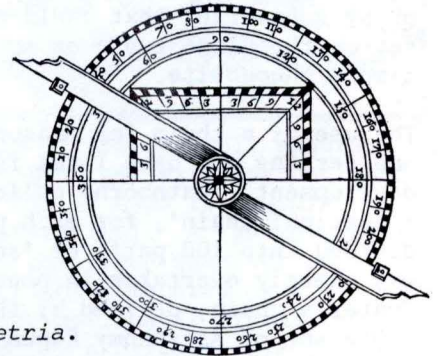


The astrolabe used to measure horizontal angles, from C. Bartoli, *Del modo di misurare*, Venici, 1614.

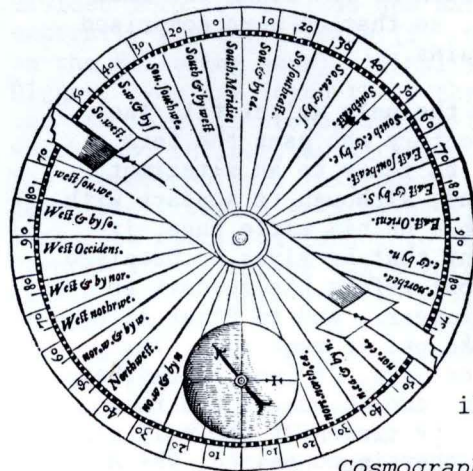
The geometric square had two sides divided into equal parts and with an alidade pivoted at the apex, or a pair of fixed sights on one edge and a plumb-bob, could be used to find heights by aligning the shadow cast by a building with the sights and measuring the shadow's length. The square would then give the proportion of shadow cast to height. The top of the building could, of course, be sighted

directly, when the use of the geometric square was similar to that of the traditional astronomical quadrant, which could also be applied to measuring altitudes in surveying.

An astrolabe is a sophisticated instrument. For surveying it was easier and cheaper to make an instrument consisting simply of the divided circle and sighting rule, with the addition perhaps of an inset compass, and a ball and socket joint for mounting on a staff. Instruments of this sort are the 'theodelitus' of Digges or the 'geographically plaine sphere' described by William Cunningham in his *Cosmographical glasse*, London, 1559. They were used for taking horizontal angles and, in particular, for triangulation, i.e. finding the position of a distant landmark by measuring angles subtended at either end of a measured base line.



Digges's 'theodelitus', from the *Pantometria*.

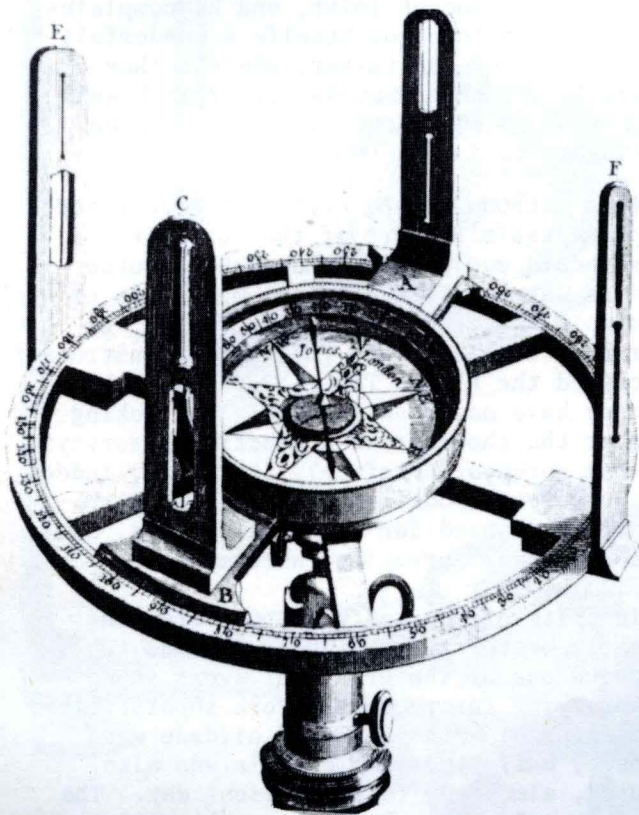


A similar instrument illustrated in Cunningham's *Cosmographical glasse*.

Cunningham wrote of his instrument: 'It is made muche like the backe parte of an Astrolabe, conteinge in the circuite. 360. degrees, and hathe a ruler with two sightes, whiche we moue to and fro, as occasion is ministred, vntill thorowe them we see the place desired. But it differeth from an Astrolabe, in that it hath a Diall, with a Nedle fixed in it, & also that th'Instrument is diuided into two & thirtie partes, like as a Shipmans compasse' (*op. cit.*, pp. 136-7).

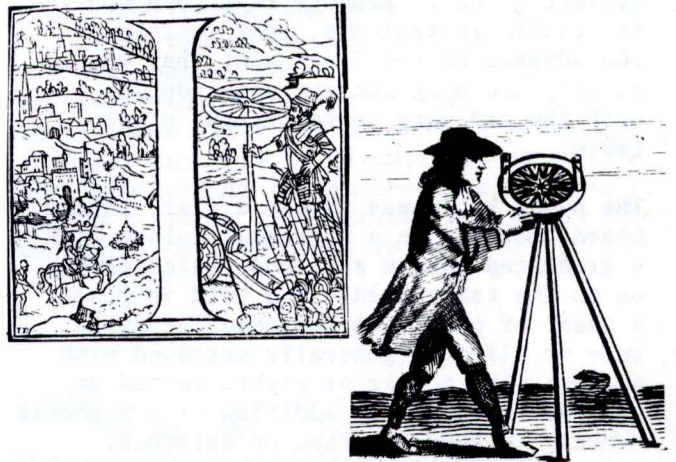
Rathborne called an azimuth instrument of this type a 'peractor', but Leybourn called it a 'theodolite' and so it was known for a long time thereafter. Leybourn does add that 'sometimes over the Box and Needle there is a Quadrant erected for the taking of heights and distances (*Compleat surveyor*, 4th edn., London, 1679, p. 43), but the quadrant is not mentioned in his description of the 'theodolite' in his *Cursus mathematicus* (London, 1690).

The term 'theodolite' was afterwards consistently used to refer to an azimuth surveying circle. This is true even when the instruments had one or two pairs of fixed sights in addition to the pivoted ones. Until the end of the eighteenth century the term 'theodolite', used without further qualification, generally refers to such an instrument and the use of the term 'circumferentor' has no basis in the primary literature. This is particularly so as 'circumferentor' is used consistently in the primary literature to refer to quite a different instrument (see page 9). Although a 'theodolite' would often have a central compass, in general the term was used for an instrument where the reading was marked by an alidade, while in a 'circumferentor' the reading was indicated by a magnetic needle.



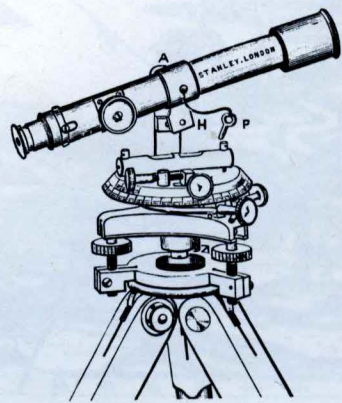
The 'common theodolite' as illustrated in G. Adams, *Geometrical and graphical essays*, London, 1803.

Cunningham's instrument in use, from the *Cosmographical glasse*.



William Leybourn's 'theodolite', from *Cursus mathematicus*, London, 1690.

Theodolites without vertical arcs were in time given telescopic sights. The telescope was arranged to pivot about a horizontal axis. Edmund Stone, for example, in his translation of Bion's *Construction and principle uses of mathematical instruments*, London, 1723, (p. 127) describes such an instrument as 'the best Theodolite, as now made in England'. (This was unchanged in the second edition of 1758.) The term 'simple theodolite' was used after the altazimuth theodolite had become the more common form. Stanley uses 'simple theodolite' in his *Surveying and levelling instruments* of 1890 (so does G.A.T. Middleton, *Surveying and surveying instruments*, London, 1894), and E.R. Watts & Son were advertising a 'simple theodolite' of this type in a catalogue of c.1930. Though other terms have been used - George Adams, for example uses 'common theodolite' in his *Geometrical and graphical essays*, 3rd edn., London, 1803 - we have chosen 'simple theodolite' to describe all azimuth instruments of this type.



The 'simple theodolite' in W.F. Stanley, *Surveying and levelling instruments*, London, 1890, p. 257.