Arianna Borrelli

Aspects of the astrolabe

I.
The interplay between manipulation of mathematical symbolism and production of natural philosophical meaning has interested me since the time I was working in theoretical particle physics. In my PhD-project, I investigate this problem-complex in an epoch in which no modern mathematical symbolism yet existed: the Latin High Middle Ages (11th and 12th centuries).
In that age, mathematical thought (here broadly taken to mean the four mathematical arts: arithmetic, geometry, astronomy and music) was essentially linked to non-written and/or non-verbal strategies of knowledge transfer, in which memory and exercise played a key role (e.g.: finger-counting, surveying methods, geometrical drawings, the Guidonian musical hand). For those trained in these thinking-schemes, no distinction between theory and application held, since a mathematical hypothesis took the form of an attempt at construction. The difference to modern mathematics becomes quite clear when considering music as a whole as a mathematical art.

II.
Focus of this research project is the astrolabe. In modern terminology the astrolabe is an astronomical instrument which offers a two-dimensional projection of the portion of celestial sphere visible (i. e.: above the horizon) at various times from a certain point on Earth. The astrolabe was invented in Late Antiquity (or earlier) and further developed in the Arabic-Islamic culture. During the 10th and 11th century, elements of astrolabe knowledge were passed on to Latin Europe.
Astrolabe knowledge was introduced in Latin Europe well before Greek-Arabic works on astronomy, mathematics and philosophy started to be translated into Latin: in the 10th century, the astrolabe and the Ghubar ciphers - an early version of positional Hindu-Arabic numerals - were the only elements of the vast corpus of Hindu-Arabic-Greek natural philosophy and mathematics to penetrate the Latin Western culture. By the 12th century, the astrolabe had been definitively assimilated into the Latin world and had even become the symbol of the liberal art of Astronomy. The Ghubar ciphers, instead, were apparently forgotten.

III.
Considering the Latin medieval astrolabe as an astronomical instrument is a necessary starting point for my research, yet, if the work has to proceed, it is just as necessary to question this definition and eventually reject it. In fact, rather than speak of "the astrolabe", it may be preferable to refer to its "aspects", which are to be understood as neither separate components nor mutually exclusive meanings, but as different ways of looking at the same complex of knowledge.

IV.

The astrolabe can be regarded as a systematic procedure for drawing points, lines and curves in such a way, that they add up to an analogical representation of celestial movements - a representation with descriptive and predictive potential. This geometrical construction is described in the oldest Latin texts on the astrolabe (11th. c.) and should not be regarded as a mere application of geometrical and astronomical theories. The construction procedure itself was the form in which mathematical knowledge about the world-order was spread: it could be learned through example and exercise and taken along in memory, eventually with the help of drawings and short notes.
The earliest Latin texts on astrolabe construction and use have been often criticized as unclear and incomplete, and most of them surely are. Yet they should not be judged according to modern criteria for scientific and technical manuals, because their aim was not so much to spread astrolabe knowledge in Latin Europe, but rather to fix into writing reflections inspired by a new knowledge that was being transmitted by non-written means.
Through the astrolabe, new ideas shaped by non-written and non-verbal strategies of knowledge transfer could find their way into theological/cosmological reflections and end up being fixed into writing - as was appropriate for that specific kind of knowledge. In particular, the mathematical and astronomical aspects of the astrolabe - probably aided by those of the equatorial sundial - provided a rational pattern to think the experience of time flow as something that could be geometrically represented as an arc of a circle and, as such, be divided into a number of parts.

V.
Under another aspect, though, the astrolabe was a machine that could be actually built - out of paper, wood or metal - and whose predictive potential could be checked against the phenomena. As such, the astrolabe strengthened the link between mathematical arts and manual crafts, which in medieval times had already been fostered by the use of similar (or even the same) non-written and non-verbal strategies of knowledge transfer, for example in the development of musical instruments, watermills or architecture. Mathematical knowledge could actually be seen to work - or not to work.
Moreover, the astrolabe could be employed as a tool for astrological predictions and "iudicia", i.e. astrological procedures to determine the most effective way and the most appropriate moment to deal with a particular problem or situation. Under this aspect, too, the device was a machine whose construction and use provided Man with a knowledge of the world which was at the same time a power to work on it. Yet again, knowledge and power were only accessible to those who knew how to construct and use that rational instrument.

VI.
The interplay of mathematics, philosophy/theology and manual crafts could eventually influence epistemological views. The construction of astrolabes, buildings, water- and windmills or, later, clockworks could be perceived as a viable means of exploring the rational structure of the cosmos. The astrolabe was an example of how men could, by rationally performing manual tasks which worked, gain understanding of the divine

rationality connecting Heaven and Earth. An expression borrowed from Vitruvius and often used in this sense in early astrolabe texts was "architectonica ratio". Like logic and grammar, it could be seen as a key to rational understanding of cosmic/divine order. And, like logic and grammar, the astrolabe, too, could be considered as dangerous heretic material.

The astrolabe shared its multiple character of abstract pattern, material tool and philosophical structure with other instruments of the mathematical arts, such as the compass, the abacus and, in particular, the monochord.

VII.

From the 11th century onward, the compass appeared in Creation images: to Latin scholars of the 11th and 12th centuries, using ruler and compass, for example to draw an astrolabe could be seen both as a mathematical construction and as an activity bringing to evidence the likeness between Man and God, the Divine Geometer, who were as one in that act of mathematical construction. This "image of knowledge" (in Yehuda Elkana's sense) was closely linked to the employment of non-written and non-verbal strategies of knowledge transfer, which up to early modern times would dominate both the mathematical and the mechanical art - as well as the rapidly expanding fields of alchemy and hermetism. In the Late Middle Ages, a growing tension developed between this epistemological stance and the one characteristic of medieval Universities, in which the word, and especially the written one, was the preferred medium for storing and transferring knowledge, while manual activities were not considered as a possible means of knowledge production.

This tension was reflected in diverging attitudes toward the astrolabe, which could be regarded as a model to be imitated, as Roger Bacon did, or as a devilish tool of heresy, as shown in the illustrations of some 13th.-century "Bible Moralisée".

A large number of commented images of Arabic-Islamic and European astrolabes can be found in the online-catalogue:

Epact: scientific instruments of medieval and Renaissance Europe. Firenze, Leiden, London Oxford (www.mhs.ox.ac.uk/epact).

For further references on the aspects of the astrolabe see:

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