

The Antikythera Mechanism: still a mystery

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Wonder piled upon wonder; I can think of no better way to describe the Antikythera Mechanism. It is an absolute gem. Plucked from a long-lost shipwreck lying beneath the eastern Mediterranean Sea¹ by sponge divers in 1900, the mechanism is, to paraphrase Winston Churchill, a mystery contained within an enigma. For those who haven't encountered the Antikythera Mechanism before, it is (though perhaps it is more correct to say was) a mechanically geared device constructed with the clear intent of 'describing' a number of solar – lunar astronomical cycles. While it is incredible that any fragments of the Mechanism survived the watery shipwreck (see figure 1), the additional fact that it was constructed circa 100 BC is even more remarkable. The mechanism is unique, having no surviving prototypes, no surviving copies and no surviving provenance. Indeed, geared mechanisms of similar sophistication were not to be made in Europe until the first half of the 14th Century. All in all, the origins of the Antikythera Mechanism are a mystery; we do not know who built it, or who designed it, and to some extent we have no clear idea of its intended use. This latter point, however, is a topic of great debate, and as with all good mysteries, there is much to tease the imagination and just enough solid evidence to hint at various design possibilities. The latest salvo in the problem fraught world of explaining the Antikythera Mechanism was published by Tony Freeth and co-workers in the journal *Nature* last November (**444**, 587 – 591, 2006).

There has been a long history of explaining the Antikythera Mechanism, and the new study by Freeth and collaborators is, no doubt, not going to be the last word on the topic. The basic problem, as illustrated in figure 1, is that the mechanism is largely in fragments and it is clear that many pieces are missing, there are, however, 30 recognized gears (most of which reside in the single fragment seen in the upper left-hand corner of figure 1). The late Yale University historian of science Derek de Solla Price published the first comprehensive description² of the Antikythera Mechanism in 1974, and in a remarkably detailed study suggested a reconstruction of the machine using a total of 31 gears. The more recent reconstruction by Freeth and co-workers (see figure 2) uses 36 gears, of which 7 are hypothetical³ (one of the surviving gear fragments isn't actually used in the new reconstruction, its purpose presently being unclear).

While the precise details of its construction may never be known, the existence of the Antikythera Mechanism clearly tells us one thing that was hitherto unknown; there must have been a vibrant community of skilled metal workers, engravers and artisans, in the ancient world over two-thousand years ago, of which at least a few must have been capable of making remarkably complex machines. The existence of this sub-culture, however, was not generally suspected until the discovery of the Antikythera Mechanism was made, and its recovery has forced historians to re-evaluate their assumptions about ancient Greek technology. There are a few vague hints within the surviving literature to suggest the existence of 'magnificent' astronomical 'machines', but no useful details or descriptions are ever provided by the ancient authors. In their recent work, Freeth and co-workers have upped the ante somewhat and suggest that the renowned philosopher

Hipparchus may have been involved in the design of the Antikythera Mechanism; a suggestion based upon their conjecture that his lunar theory is incorporated within the surviving gearing. We, of course, will probably never know if this is true or not⁴.

Many suggestions have been made concerning the intended user, or users, of the Antikythera Machine, but the issue continues to remain unclear. Why was it built? In spite of its sophistication, it seems reasonably clear that it was not intended to make precise predictions of astronomical phenomena. Firstly the gearing ratios and hand-crank operation of the Mechanism, while good, would have at best only provided approximated times at which, for example, eclipses would occur, and at what approximate times various planetary alignments might take place. At best the machine would have only followed what ‘astronomers’ already knew was likely to be happening in the sky – there is no apparent means, for example, of ‘setting’ the device to some specific date into either the future or the past⁵. Second, one could argue, the prediction of eclipse times and other astronomical phenomena were achieved well-enough through hand and table-based calculations by scribes distributed throughout the ancient world, who had no apparent access to similar such machines. The other point being that such information was not actually deemed to have any great value in ancient Greek society. In addition, the complex construction and intricate workings of the Antikythera Mechanism rule out its use as a ‘visual’ demonstration piece - showing, as it were, the ‘clockwork’ of the heavens. This all suggests that the Antikythera Mechanism was actually an exhibition device, probably (one might conjecture) built for a rich patron, who never actually used it, by a singularly gifted craftsman. The Antikythera Mechanism is a treasure for sure, but

a calculator built for real astronomical (or astrological) use, by a practicing astronomer (or astrologer – thought there was no ancient distinction between the two occupations), mostly likely not.

Notes and references

1. The story behind the Antikythera Mechanism's discovery is given by J. Marchant (2006, *Nature*, **444**, 534 – 538). It is generally agreed that the shipwreck from which the Mechanism was recovered was a treasure-ship returning to Rome with looted plunder from Asia Minor circa 85 – 60 BC. Details concerning some of the recovered cargo are given in G. D. Weinberg *et al* (1965. *The Antikythera shipwreck reconsidered*. *Trans. Am. Phil. Soc.* **55**, 3 – 48). Additional background details can be found at http://en.wikipedia.org/wiki/Antikythera_mechanism.
2. Price, D de S. 1975. *Gears from the Greeks*. *Trans. Am. Phil. Soc.* **64**, 1 – 70. An 'expanded' reconstruction of the Antikythera Mechanism is given by M. T. Wright (2002. *A planetarium display for the Antikythera Mechanism*. *Horological Journal*, **144**, 169 – 173). The general consensus among present-day commentators is that Price's reconstruction of the Antikythera Mechanism is no longer valid.
3. The fact that a number of the surviving gears are only partially preserved means that there is an unavoidable uncertainty in the measurement of their physical size and teeth counts. Freeth *et al* provide a summary of teeth count determinations in a supplement to their paper – see:
<http://www.nature.com/nature/journal/v444/n7119/supinfo/nature05357.html>. A

detailed description of each surviving gear fragment is provided by M. T. Wright (2005, *The Antikythera Mechanism: a new gearing scheme*. Bull. Sci. Inst. Soc. No. 85, 2 – 7).

4. I should point out that the details presented by Freeth and co-workers do indicate that the Antikythera Mechanism had a gear and pinion system that allowed for a lunar anomaly correction of about the size advocated by Hipparchos. To argue that Hipparchos was actually involved in the design of the Mechanism, however, stretches very thin data too far. This being said, it certainly appears that the machine incorporated within its design the very latest in astronomical thinking.
5. It is true that the various dial fragments do show zodiacal and calendaric scales, but to access data concerning say potential eclipse events many months or years into the future or events that occurred in the distant past would not have been possible – short of excessive amounts of winding upon the machine.

Figure 1: The 82 fragments that constitute the Antikythera Mechanism. For further details and images see: http://www.xtekxray.com/antikythera_images.htm. See also the web page for the Antikythera Mechanism Research Project at: http://www.xtekxray.com/antikythera_images.htm.



Figure 2: On the left is an X-ray image of the largest gear-containing fragment of the Antikythera Mechanism, while on the right is a computer generated image of the recent gearing arrangement proposed by Freeth *et al.* Further images can be seen at:

http://content.techrepublic.com.com/2346-10877_11-38336-1.html. Animations of the

mechanism in action can be downloaded from

http://www.etl.uom.gr/mr/index.php?mypage=antikythera_ani.

