

# The gears of the Antikythera Mechanism: an educational pathfinder to the solar system

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**Abstract.** The Antikythera Mechanism is the most sophisticated extant ancient astronomical instrument and analogue computer known and was assembled sometime between 150 and 100 BCE, almost a century after the death of Archimedes. The mechanism has a great educational potential as it appeals to inquiring minds as an astonishing artefact of science and technology. The latest research findings reveal significant cultural and social functions in its operations. This astonishing astronomical instrument has a clear interdisciplinary value and it has that it may be used as an educational medium, to engage the general public, and especially to attract students both to/from exact sciences and to/from the humanities. The astronomical and technical knowledge embedded in the mechanism can also be used to introduce some aspects of modern science through the unknown technological achievements of Hellenic antiquity.

**Keywords.** Antikythera Mechanism, astronomical instruments, education, modelling, outreach.

## 1. Introduction

The Antikythera Mechanism is an astonishing astronomical instrument of the ancient Hellenic world. The unknown craftsman constructed it with gears made of bronze to carry out astronomical calculations. The construction made up of gears with carefully-designed transmission ratios makes possible to perform the computations in the rational numbers domain. The instrument probably epitomises all the astronomical knowledge of its era. The Mechanism is a unique artefact in many ways –and the only device of its kind known today. It is both an astronomical instrument (Rediadis 1903) and an analogue computer (Price 1959, 1974; Theofanidis 1934). Scientists and engineers understood its priceless value since the day of its discovery (Svoronos 1903).

It was discovered in 1901-2 near the small Greek island of Antikythera during a sponge dive (Svoronos 1903). The fragments were part of the cargo of a large shipwreck of the 1st century BCE that was full of treasures been transported from Greece to Rome. This intriguing and mysterious device has perplexed many scientists who have been studying it through today (Moussas 1991; Freeth et al. 2006, 2008; Wright 2007). The research studies of the Mechanism continually unveil extraordinary information about the ancient Greek science and technology, some of which are unknown and very surprising. It is an instrument whose study leads to a complete revision of the history of science, technology, astronomy, mathematics and even philosophy.

The ancient instrument of the Mechanism has many dials with circular and two spiral displays, with pointers, some of which are quite complex. One dial is on the “front” and the rest of the dials on the “back” side of the Mechanism. The pointers are driven by gears that rotate by a single input shaft (Freeth et al. 2006, 2008; Price 1959, 1974; Theofanidis 1934). The device was originally housed in a wooden case, with its manual

written on every available surface of the Mechanism. It appears to have been constructed between 150 and 100 BCE (Charis Kritzas, 2006, private communication).

The bronze fragments of the original are on display at the National Archaeological Museum of Athens and they are being globally investigated, like other important items of astronomical instruments.

## **2. The interdisciplinary value of the Antikythera Mechanism**

As technology penetrates into the global community's daily routine, people find themselves in need of different types of technology applications and gadgets that they have to use every day. As a result, they need to develop special skills and acquire appropriate knowledge in order to understand the way things work and avoid the possibility of looking at them as mere offsprings of magic. Despite its mysterious and complex nature, the Antikythera Mechanism is a unique educational resource and tool. It is suitable for teaching modeling of nature by using laws of nature, mathematical methods and the translation of the gears' motions into mathematics. The Mechanism is the oldest known mechanical device in the history of civilisation, which proves that science can model the universe with mathematics, astronomy and engineering.

The Mechanism is a great attractor to children for science, mathematics and technology, but also for astronomy, philosophy, history, linguistics, geography, modeling, physics, metallurgy and many more (Moussas et al. 2007). Therefore, exhibitions around the world (see Table 1 below) highlighting the Mechanism, offer a tremendous opportunity for interaction between scientists and the public. For example, the Children's Museum of Manhattan (CMOM) in New York City is the only museum in America currently showcasing a reconstruction model of the Mechanism. Also, through their short audio-visual presentation visitors, from age 6 to adults, learn that it was the ancient Greek understanding of causality that led to the development of the scientific method we use today. At a nearby interactive kiosk, visitors learn how modern technology is being used to unlock the mysteries of the Antikythera Mechanism and learn how this Greek machine is altering our understanding of the history of science (Roumeliotis 1999).

These versatile events focus on the display of an exact replica of the Antikythera Mechanism in the same scale as the original. The reconstruction models depict the Mechanism's geared infrastructure and reveal its brilliant operation. Apart from the reconstructed device, each exhibition includes multimedia interactive software that enables the visitor to watch the history of the Mechanism as well as investigate and understand its functions and capabilities. In addition, elucidatory panels are on display at the surrounding area, in order to involve the visitor in the roots of science and astronomy. During the exhibitions, public lectures concerning the amazing story of the Mechanism are given to the general public, introducing ancient technology. In turn, this allows visitors of all ages to easily view the conjunction of modern science and historical heritage through the Antikythera Mechanism –and continue the conversation at home! Most importantly, these exhibitions constitute a dynamic way for studying and learning more about astronomy, mathematics and science, revealing the interdisciplinary value of the Antikythera Mechanism.

The Antikythera Mechanism is an incredibly resourceful and educational tool for changing the way the general public views Science and assists people to approach astronomy, mathematics, science and philosophy.

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**Table 1.** Overview of exhibitions of the Antikythera Mechanism.

Event	Place	Date	Visitors
National touring exhibition <i>Gods, Myths and Mortals: Discover Ancient Greece</i> , Children's Museum of Manhattan	Hellenic Museum, Chicago, USA New York, USA	2010 2007–2010	500,000
Aurora Polaris, Grundtvig University of Patras Center	Olsztyn Planetarium, Poland Patras, Greece	May-Sep 2009 Mar 2009	10,000 2,000
Culture Center City of Rehtymnon	Rehtymnon, Greece	27-30 Mar 2009	300
Museum Gustavianum, Uppsala	Uppsala, Sweden	31 Jan-29 Apr 2009	10,000
Inauguration of IYA 2009 + IAU Symposium 260	UNESCO, Paris, France	15-23 Jan 2009	2,500
Planetarium Science Center Bibliotheca Alexandrina exploratorium	Alexandria, Egypt	1-30 Nov 2008	2,000
Zappeion, Research and Innovation exposition	Athens, Greece	Nov 2008	3,000
Abet Greek School in Cairo	Cairo, Egypt	29 Nov 2008	300
Exhibition at CRAAG	Algiers Observatory, Algeria	2 Nov 2008	50
7ème Salon d'Astronomie	Constantine, Algeria	30 Oct-1 Nov 2008	6,000
Ionic Centre	Athens, Greece	22 Oct-14 Dec 2008	7,000
HELEXPO/DETH Intl Fair	Thessaloniki, Greece	Sep 2008	4,000
Aurora Polaris, Grundtvig	Athens, Greece	Sep 2008	30
Church Children Camp N. Makri	Alexandroupolis, Greece	1 Aug 2008	140
Amphitheatre of Gymnasium	Kasos, Greece	30 Jul 2008	300
Karditsa Cultural Center	Karditsa, Greece	28 Feb 2008	300
City of Chios	Chios, Greece	9 Feb 2008	200
City of Ermioni	Ermioni, Greece	Feb 2008	120
HELEXPO/DETH Intl Fair	Thessaloniki, Greece	Sep 2007	4,000
Municipal Theatre	Alexandroupolis, Greece	5 May 2007	180
Zappeion, Research and Innovation exposition	Athens, Greece	May 2007	3,000

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