




Historical Significance and Modern Impact of Al-Jazari's Elephant Clock

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Abstract. The elephant clock, an astonishing automaton and mechanical marvel devised by al-Jazari in the 13th century, is an enduring symbol of Islamic engineering and innovation. This remarkable creation exemplifies the intricate fusion of art and engineering that epitomized the Islamic Golden Age. The study delves into the cultural and technological context surrounding the invention of the Elephant Calendar, shedding light on its multifaceted impact. Moreover, al-Jazari's genius has left an indelible mark, as the elephant clock was meticulously re-engineered and recreated after a span of 8 centuries, attesting to its timeless appeal and historical significance. In conclusion, this comprehensive research illuminates the historical importance of the elephant clock and its enduring relevance in the modern world. As an iconic representation of the ingenious blend of technology and creativity in Islamic history, the elephant clock continues to inspire and captivate both scholars and enthusiasts, highlighting its remarkable journey through time and its continued influence in contemporary society.

Keywords: Elephant clock · automaton and mechanics · al-Jazari · history

1 Introduction

The Elephant Clock is a water clock invented by Al-Jazari. It is regarded as a form of art designed to express the universal structure of the Islamic world. This unique creation spread throughout Europe and Central Asia during the Islamic Golden Age.

In order to understand the elephant clock, it is necessary to examine the life and times of its inventor. The full name of al-Jazari (1136–1206), who worked as chief Engineer of the Artuqid palace in Diyarbakır (now a city in Turkey), is Bedi Üz-Zaman Ebu'l-İzz İsmail b.er-Rezzaz al-Jazarî. The Mesopotamian engineer, who lived in Jazira between the Euphrates and Tigris Rivers, inspired today's robotic technology by designing extraordinary mechanical tools. al-Jazari, who is also known as the founder of robotics, took his place in world history as the “Greatest Scientist of the Middle Ages” thanks to his works created with engineering beyond his time [1, 2].

His works, which feature complex movements using gravitational acceleration, water and air pressure, are considered the first robots in world history. He left an important legacy to the world of science and engineering with his work titled “The Book of Knowledge of Ingenious Mechanical Devices” [3].

Al-Jazari lived in the period called the Golden Age of Islamic Science. This period, during which great advances have been made in a number of fields of science, mainly astronomy, mathematics, medicine and engineering, has lasted from the 8th to the 13th centuries. The foundation for modern science and technology, as well as the contribution it makes to these important developments has been established by Islam's scholars and inventors like al-Jazari. During this period, the Islamic world contributed significantly to developing science and knowledge in creating a historical legacy.

The elephant clock is a spectacular example of al-Jazari's unique invention. This work, completed in 1206, is considered to be one of the most sophisticated mechanical works during this period. The clock's not just a watch; it's an artwork, blending form with function in ways that few innovations of the time were able to do. It is an expression of al-Jazari's engineering genius, as well as his taste in art. The elephant clock is a masterpiece that measures time in thirty-minute intervals, using the theories known today as Newtonian dynamics and Pascal's principles. The elephant clock was presented a perfect combination of art and engineering. It is a colossal clock with the height of almost five meters [3]. The design brings together a number of fundamental elements at once that proves to be an extraordinary example of complexity. The figure of elephant clock are shown in Fig. 1.



Fig. 1. The elephant clock that designed by al-Jazari [4].

The figure on the castle is believed to be Selahaddin Eyyubi (1137–1193), which al-Jazari used to show respect for the great leader.

Relying on the Archimedean water principle, Indian elephant, Egyptian phoenix, Arabic figures, Persian carpets and Chinese dragons, Jazari has reflected the richness of the Islamic world in his works.

There are various mechanized figures such as elephant, phoenix and dragon. These figures represented different civilizations. The figures used in the clock also symbolized countries and trade. Each holding a figurine symbolizing an animal or a legendary creature; elephant represents royalty and nobility, phoenix symbolizes rebirth and life, and dragon represents power and invincibility. These figures moved in harmony to represent the passage of time.

2 The Mechanism of the Elephant Clock

The mechanisms of work of elephant clock was based on today's Newtonian dynamics and the principles of Pascal. The main feature of this clock is a bowl with a hole in the bottom, which is rotated around its mouth and completes its one-hour cycle. This feature forms the heart of the time measurement system. The perforated bowl floats in a water tank placed on the elephant's belly. The container filled with water sinks slowly and tilts to its side, while pulling the three ropes attached to it. These three ropes activate the thirty balls released one by one, control the movement of the dragons and the scribe figure, which rotate around itself. It takes exactly half an hour for the bowl to fill, sink and a new cycle begin. When the bowl sinks to the bottom, it makes a flute-like sound that resembles a bird's voice, and the Phoenix rotates around itself. Meanwhile, a free ball turns the dial behind the Selahaddin Eyyubi figure. The figure of Selahaddin Eyyubi, turning to the right or left, decides that falcon will release ball with this movement. The dragon descends under the weight of the ball left by the falcon and falls into its mouth, and drops the ball into the vase behind the elephant keeper. This moves the elephant keeper's arm and a buzzer sounds as the ball enters the vase. On the dial above Selahaddin Eyyubi, circles that fill halfway every half hour show the time. This series of movements continues, repeated every half hour [5–7]. The mechanisms of work of elephant clock are shown in Fig. 2.

The task of each figure is as follows:

- Phoenix: Phoenix tours every half hour accompanied by its voice.
- Dial: Clock interface that shows how many hours have passed.
- Selahaddin Eyyubi: When he moves his arm, a falcon appears.
- Castle: It contains thirty cannons that start the chain of events.
- Falcon: The ball released from the goal travels behind the falcon's head and out of its beak.
- Dragon: Catches the ball coming out of the falcon's mouth and descends towards the elephant.
- Scribe figure, which acts as a minute hand, rotates every half hour and returns to its first position.
- Elephant Keeper: His arm moves when the ball falls from the dragon's mouth into the vase. With this last movement, one round is completed.

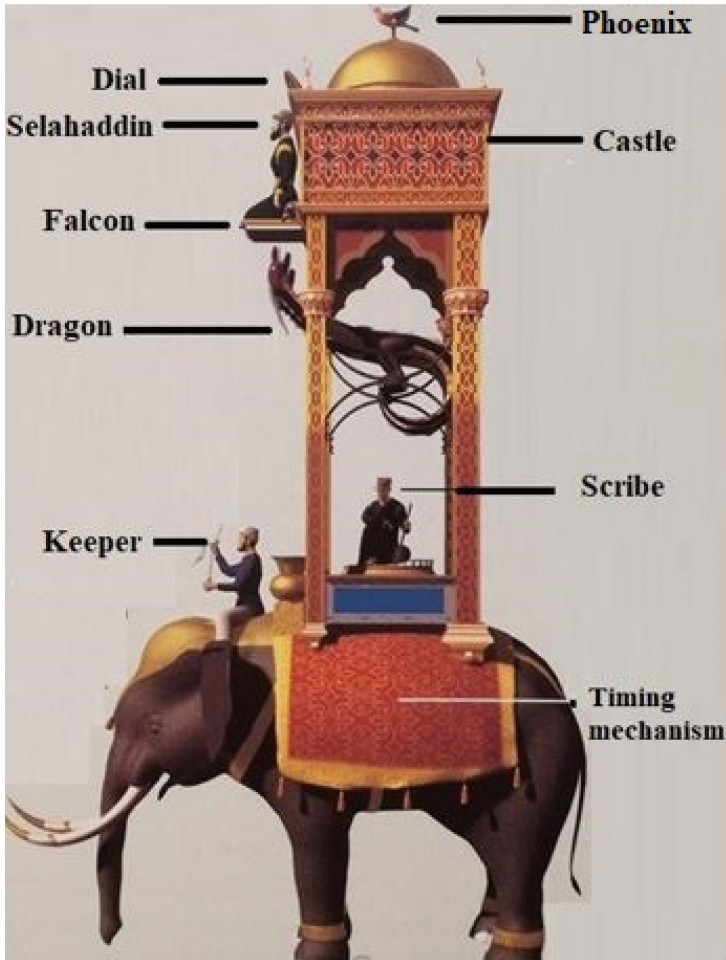


Fig. 2. The mechanisms of work of elephant clock [6].

3 Rediscovery and Reinterpretation of the Elephant Clock

For centuries, the existence of elephant clock was mostly forgotten. With the discovery of the clock by historians in the 20th century, there was an interest in re-establishing for this wonderful system.

After 800 years, Hidropar Motion Control Technology Center (HKTMC) has taken the concept of the elephant clock and elevated it to new heights by using cutting-edge technology and precision engineering. They have meticulously renovated this historical treasure while remaining faithful to the original design, preserving its historical and cultural significance.

The elephant clock, which was built by HKTMC, contains more than 4000 parts made of chrome alloy stainless steel, brass and bronze. It took more than two years to complete. Some photos of the elephant clock re-establishing process are shown in Fig. 3.



Fig. 3. Some photos of the elephant clock re-establishing process.

In this design, the elephant clock statue is 3.7 m high and weighs an average of 2.5 tons.

There is no human figure in the restricted elephant clock. Only three of the four animal figures in the statue; Chinese dragon, African elephant and phoenix were used. The photos of the completed elephant clock, which was re-established by HKTMM, are shown in Fig. 4

As mentioned above, in mythologies, the dragon represents power, the elephant represents nobility and the Phoenix represents cycle and rebirth. In addition to these metaphors, it was envisaged that the same animal figures could be adapted to the international trade scene, and it was thought that the dragon and African elephant would symbolize Asia and the African continent respectively. The phoenix represents Anatolian geography, symbolizing the birth of civilizations.



Fig. 4. The photos of completed elephant clock which re-established by HKTМ.

The animal types in the work are depicted in harsh poses because they represent powerful war instruments such as trade and technology in our age. However, the fact that all the characters actually cooperate and complete the time cycle is identified with the working principle of the clock.

In a relatively fast-paced world, the thirty-minute working period of the clock has been halved to emphasize the human need to measure time, which is shorter each day than the previous one.

Although al-Jazari used the Asian elephant (Indian elephant), which had an important role in the commercial conditions of the period in which he lived, the artist (İskender GİRAY) preferred the African elephant in this clock because he wanted to underline the resource exploitation of all countries in the world on the African continent in today's conditions. The globe, which is placed under the African elephant's feet, representing the world that lives in.

In the anamorphic reflection obtained from the distorted piece on the sphere, an elephant corpse with its tusks stolen can be seen. This corpse is actually a real-world representation of the African elephant. Thus, the artist mirrors the responsibility that the individual should feel.

This clock uses a mechanism that has been interpreted today with technological elements from various specialized fields.

Today, this clock works as follows:

- First, a mechanical movement rotates the minute hand a quarter of a turn.
- Robotic Phoenix flaps its steel wings and carries the ball over the top of the clock.
- The ball is placed in the mouth of the Chinese dragon.
- The dragon spins the ball around its axis with its own weight and releases it from its mouth.
- The ball, which empties the water container in free fall, passes the African elephant with an automatic system and returns to the starting point in a clockwise direction.
- At this point, the phoenix spreads its wings and takes the starting position of the new cycle.

This process ensures that every movement of the figures in the sculpture is repeated in fifteen-minute periods, ensuring that the cycle continues continuously. The function of this technological machine, in today's terms, explains the al-Jazari blue elephant clock.

4 Conclusions

The elephant Clock represents the highest level of awesome engineering and an evidence to the intellectual performance of the Golden Age of Islamic Science. In a world where we usually don't pay attention about keeping time, Al-Jazari's inventions reminds us how significant knowledge, innovation, and art can be. It shows that humans have always been clever and creative. This invention links the past and present, still inspiring us today. In a world filled with new technology, it's vital to respect and appreciate the people who set the period for the things that make our lives better now. As HKTM, it is our mission to preserve the unique and valuable heritage of Al-Jazari in the Anatolian and Mesopotamian lands.

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