International Symposium on History of Machines and Mechanisms - Proceedings HMM 2000

Edited by Marco Ceccarelli

Kluwer Academic Publishers
International Symposium on History of Machines and Mechanisms
Proceedings HMM 2000

Edited by Marco Ceccarelli
Dipartimento di Meccanica, Strutture, Ambiente e Territorio,
University of Cassino, Cassino, Italy

KLWNER ACADEMIC PUBLISHERS
DORDRECHT / BOSTON / LONDON
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DRAWINGS OF AUTOMATAS IN MIDDLE AGE

Michela Cigola, Arturo Gallozzi
Università degli Studi di Cassino
Dipartimento di Meccanica, Struttura, Ambiente e Territorio
via G. Di Biasio 43 - 03043 CASSINO (FR), Italy
Email: cigola@ing.unicas.it

Abstract: Aim of this work is to delineate history of automatons from antiquity to Middle Age by focusing the attention on two medieval authors: al Jazari and Villard de Honnecourt. The development of the work will be carry out by the analysis of drawings from ancient texts

Keywords: Drawing, History of Drawing, History of science, History of machine and mechanisms, Premedieval and Medieval scientific culture.

INTRODUCTION

Construction of the first automaton, a flying dove, can be attributed to Architas of Tarantum (a pupil of Pythagoras, mathematician and musician 6th century BC) but it can be presumed that mechanical devices were used much earlier to give an illusion of life to men and animals during religious ceremonies and in theatrical performances with the deus ex machina. We find documentary evidence of the established presence of mechanisms and automata in Greek antiquity in various authors, including Aristotle [1].

In the school of Alexandria mechanical themes were studied and in particular by great attention was addressed to those associated with the construction of automata. In fact Ctesibius (3rd century BC), who is considered the founder of the Alexandrine school of Mechanics, studied and applied the basic principles of pneumatics by creating automata which are operated by the force of air. He is also remembered for being the first to create a water clock. His pupil Philon of Byzantium worked particularly on automata, basing their operations on pneumatics and the principle of communicating vessels. An important advance for construction of automata is due to Heron of Alexandria, who probably lived in the 2nd or 1st century BC and collected and developed the works and knowledge of his predecessors. Heron was interested not so much in the practical utility of his devices as in their ability to astound and stupefy, to appear as reflections of a magical and supernatural world. Among his writings we may mention Pneumatica, with the most varied applications of the effect of atmospheric pressure on bodies (siphons, water organs, the so-called "Heron's fountain", statues that emitted sounds) and Sul teatro automatico in which his mechanical inventions are presented as automata in human or animal form that execute very simple movements.

Heron's treatise on automata in which the construction of small mechanical theatres is clearly described, was disseminated in Italy in the 1500s, particularly by G.B. Aleotti, an author who worked on Mechanical. In figure 1a, an application of third theorem by Heron is shown to indicate how to construct a mechanical theatre with the representation of a forge where some blacksmiths hammer iron on an anvil being, the whole operated by water power from a channel.

In this as in all the other illustrations added to Heron's treatise (which was reproduced without illustrations) Aleotti tried to make Heron's devices explicit, fitting them, however, into backgrounds drawn with great accuracy and giving the same attention to the purely decorative parts as to the mechanical details.

In the Roman period, great attention to mechanisms for automata was given by Vitravius, who was a mulifaceted figure of architect and engineer in the imperial age. In 27-23 BC he dedicated his work De architecture to Octavian. This work, which came down to us without illustrations, was republished during the Renaissance several

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automata and in the choice of colours, but also in the design of the entire plate, in which the weight of the part illustrated and that of the text are perfectly balanced.

**Villard de Honnecourt** (Honnecourt-sur-Escaut, 12th century) was born in Picardy, in a village beside the abbey of St. Pierre, where he may have studied in the workshops and made use of the library, which had some ancient manuscripts on technical and scientific subjects [8].

The drawings in his *Notebook*, dated as 1225-35, are usually arranged four or five to a page, in a balanced composition of text and drawings in a summary framework. Some of the objects are drawn in plan, others in perspective or in section, in a very expressive graphic language.

On sheet 22x of his notebook, completely devoted to mechanics, and it is of the most beautiful in both layout and its graphic components (Fig. 5a), we find the mechanism of a rotating angel. The clock mechanism that caused the movement of the angel "which constantly indicates the sun" is sketched simply but exhaustively in elevation, showing the system of weights that allowed the angel to move, while the angel itself is not shown in order to focus the attention of the reader on the mechanism as opposed to the figure of the automaton. This is because the Notebook was addressed to a technical reader who were not to be astonished by the marvellous appearance of the angel but need to understand how the miracle took place.

![Fig. 5a-5b. Villard de Honnecourt. a) Angel pointing the sun. b) Eagle automata in “Livre de Portraiture” [9]](image)

Presumably the angel was constructed to move about the pole that appears on the extreme left of the illustration and its rotation was permitted by the wheel driven by ties and counterweights.

The representation of the mechanism of the angel is in elevation, but the wheel is turned over to show the circular shape and to better summarise the different aspects of the object shown in a single drawing. There are also some of the very first attempts at graphics standardisation, due to a sketching and abstraction of the contingent aspects of the material object. For example you can recognize an use of a sinusoidal line to represent the rope, even though it is certainly in tension.

On the same page we also find the automaton of the eagle (Fig. 5b) which is presented in Villard’s text, as "must turn its head towards the deacon on the reading of the gospel”. It is probably the oldest image of a western automaton that has come down to us. This representation, which is another proof of Villard’s great ability as an artist, is an able combination of perspective and section, with pictorial connotations in the treatment of the feathers on the wing. The device for transmission and transformation of movement is clearly delineated, based on a mechanism of pulleys and counterweights that allows the bird’s neck, fixed on a vertical axis, to rotate thanks to a cord and series of pulleys. These two automata, operated by counterweights and rope transmission with pulleys, certainly connect to techniques going back to Heron’s automata, and even if their application in Villard enters the spiritual field and religious function, it cannot but be linked to precedents in the tradition of the *deus ex machina* of the classical Greek theatre.
CONCLUSIONS
After the Medieval period, the technique of automata had its period of greatest development with the revival of classical Greek and Roman culture in the Renaissance which was accompanied by undoubted progress in the scientific and technical field in general. The writings of Ctesibius, Philon and Heron particularly, were preserved and transmitted to subsequent epochs through the translations of Arabs and Byzantines. They became part of the culture of wide strata of the population and exercised a considerable influence on the development of technology. The same cannot be said of the works of the medieval authors, which probably remained known to only a few initiates until their rediscovery in modern times.

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