Robots in History: Legends and Prototypes from Ancient Times to the Industrial Revolution

A. Gasparetto

Abstract Even in ancient times the idea of "robots", intended as artificial beings that could substitute real individuals to carry out heavy and repetitive tasks, flourished and led to the birth of many legends. In addition, several ingenious inventors, belonging to different epochs and civilizations, designed and built prototypes of what we can define "robots". In this paper, we sketch a brief history of Robotics throughout the centuries, from ancient times to the Industrial Revolution (18th century), describing the most interesting legends and the most relevant examples of robot prototypes that were designed and/or built.

Keywords Robotics · Automata · History · Prototypes · Legends

1 Introduction

The idea of artificial beings that could substitute real individuals, especially to carry out heavy tasks, dates back to ancient times, with the birth of many legends, among different cultures and civilizations. For many centuries, however, artificial devices could not be built because the technology was not developed enough. Only after the Renaissance, a significant progress in technology, especially in the methodologies for metal processing, enabled the most ingenious inventors to build autonomous mechanical devices.

There are not so many books or journal papers devoted to the history of Robotics. A historical overview may be found in the work by Ceccarelli [6], or in the book by Rosheim [20], or within the book by Rossi et al. [22]. Some information on history of Robotics may be found in Wikipedia [12].

This paper presents a synthetic history of Robotics from ancient times to the 18th century, i.e. to the time when the progress of the Industrial Revolution set the basis

A. Gasparetto (✉)
Polytechnical Department of Engineering and Architecture,
University of Udine, Udine, Italy
e-mail: alessandro.gasparetto@uniud.it

for the widespread diffusion of automatic devices in the industrial environment, thus ending the "amateur" era of Robotics.

The paper is organized as follows. In Sect. 2, legends created by ancient cultures, concerning artificial individuals or beings, are described. In Sect. 3, the most relevant designs and prototypes of artificial beings conceived up to the 18th century are described and discussed. In Sect. 4 conclusions are drawn.

2 Legends

Many legends about "robots" flourished in different epochs and civilizations. In ancient Egypt, the priests used to make animated statues to communicate the divine will to the people. In the Canadian far north and in the Western Greenland the Inuit legends tell us of *Tupilaq*: anthropomorphic beings that could be created by a sorcerer to hunt and kill enemies.

In the Greek mythology there are several tales concerning "robots". The most famous one is the myth of Pygmalion, a sculptor from Cyprus who made an ivory statue of a girl and called it Galatea (Fig. 1). The statue was so realistic that he fell in love with it and wished it could become a real woman. Eventually, Aphrodite, the goddess of love, fulfilled his wish and Galatea came to life. The most beautiful
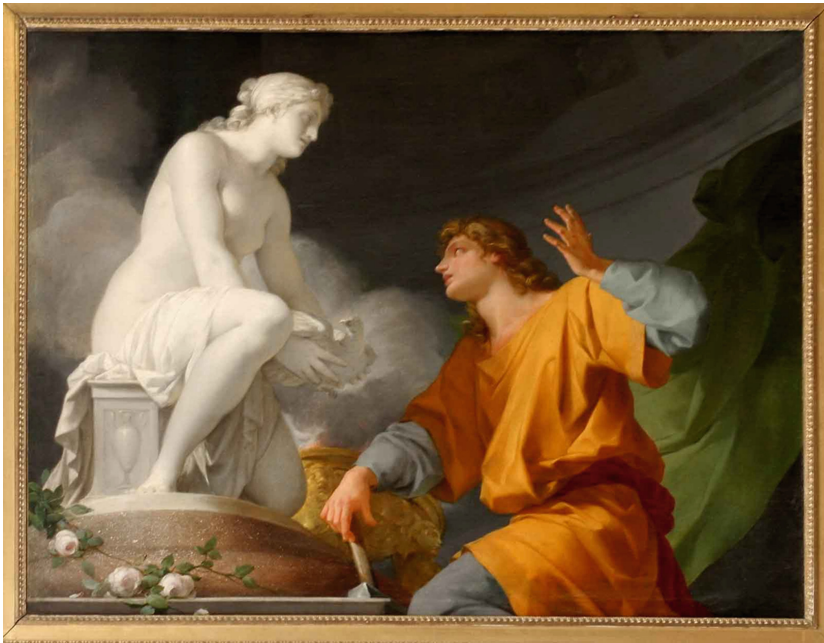
Fig. 1 "Pygmalion priant Vénus d'animer sa statue", by Jean-Baptiste Regnault (1786). Salon des Nobles du Château de Versailles (*source* Wikimedia Commons)

version of this myth can be found in the *Metamorphoses* by Ovid [17]. In another myth, Cadmus killed a dragon and buried its teeth, which suddenly turned into armed soldiers. With these men, Cadmus founded the city of Thebes and became its first king [13]. Moreover, according to classical mythology, Hephaestus, the crooked God of metals, created mechanical servants of various types and complexity, varying from intelligent golden young ladies to more utilitarian three-legged tables that could move autonomously [14]. Another example of a robot that can be found in Greek legends is Talos, a gigantic bronze automaton built by Daedalus to defend the island of Crete by throwing huge boulders against an attacking fleet [14]. Some other legends tell us that in Thebes were built statues able to speak and move their arms, while in Heliopolis it was possible to admire statues that could come down from their pedestals.

The idea of anthropomorphic beings was not considered in the first centuries of the Middle Ages, mainly due to religious taboos. Only in the 13th century the idea of some sort of "robot" came back to life. According to a legend, the philosopher Roger Bacon (1214–1294), a Franciscan monk, built a brass head that could talk and answer to any possible question [5]. A similar head was owned by St. Albertus Magnus (1200–1280), philosopher and Doctor of the Catholic Church.

In the 16th century, it was the turn of the alchemists: they gave "recipes" to build not only the head, but even the entire body of an artificial anthropomorphic being, which they named *Homunculus* ("small man") [11]. The recipe provided by Paracelsus (Philippus Aureolus Theophrastus Bombastus von Hohenheim, 1493–1541), the famous Swiss physician and alchemist, contributed to the birth of the legend of Faust.

The idea of artificial anthropomorphic beings is present also in the Jewish culture: such beings are called *Golem*. The most famous Golem legend dates back to the 16th century: the rabbi of Prague, Judah Loew ben Bezalel, created the Golem to save Prague Jews from antisemitic attacks. He went at night to the Vltava River with two of his assistants, and with the clay of the river banks they shaped a human figure. At the end of the rite, the rabbi imprinted on the front of the creature a holy word, which gave life to the inanimate matter. The Golem was able to read people's minds, thus identifying those who wanted to harm the Jews [15].

3 Designs and Prototypes

In addition to legends, the ancient Greek world left us some examples of technical designs of automata. According to Diogenes [8], the first design of a "robot" can be considered the one proposed by the Greek mathematician Archytas of Tarentum (428–347 BC), who conceived the first ever known artificial machine: a bird-shaped device named "*the pigeon*" that could fly under the propulsion of steam.

Diogenes [8] also tells us of Ctesibius (285–222 BC), a Greek mathematician living in Alexandria, who made several inventions, among which some automata intended to "please the eye and the ear": a blackbird that sang by means of a water

flow, as well as human figures which could drink and move. Ctesibius also invented a water organ that is considered the precursor of the modern pipe organ, and a water clock that for many centuries (before Huygens' pendulum) was the most accurate clock in the world (Fig. 2). Some time later, Hero of Alexandria, a mathematician and engineer who lived in the first century AD, in his work *Automata* [4] described some devices that, using the steam produced by a rudimentary boiler or the force generated by a water jet, made statues move, as in Fig. 3.

In ancient China, some inventors designed ingenious automata. An interesting example is the *Cattle Machine* (described in [24]), which was used for transportation of heavy loads. In 1088 Su Song (1020–1101 AD) designed the *Cosmic Engine*, a clock tower featuring mechanical dummies that could sound the hours, ring the gongs and the bells of the device [16].

In Arabic civilization, the inventor Al Jazaari (1136–1206 AD) designed several automatic devices, including musical automata powered by water and humanoid robots that could play music and entertain during the royal parties (Fig. 4). The interesting feature of these robots lies in the fact they could be "programmed" by adjusting the cams that implemented the percussion on the drums, thus allowing to play different melodies [2]. In Japan, until the end of 18th century, some automata were built for the amusement of rich people. The most popular version was the "tea maidservant", a humanoid device which could move and offer a cup of tea (Fig. 5).

In order to see the first projects of automata in the Western world, one must wait until the latest centuries of the Middle Ages. Villard de Honnecourt, a French artist and engineer of the early 13th century, drafted several automata: however, they were more sketches than designs in a modern sense.

Fig. 2 The water clock by Ctesibius [18]
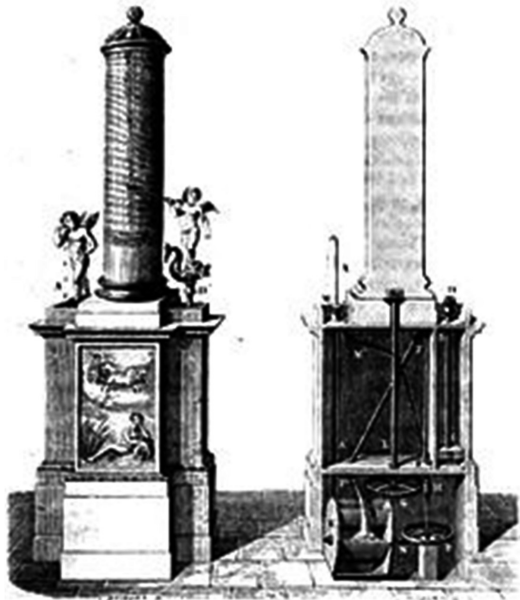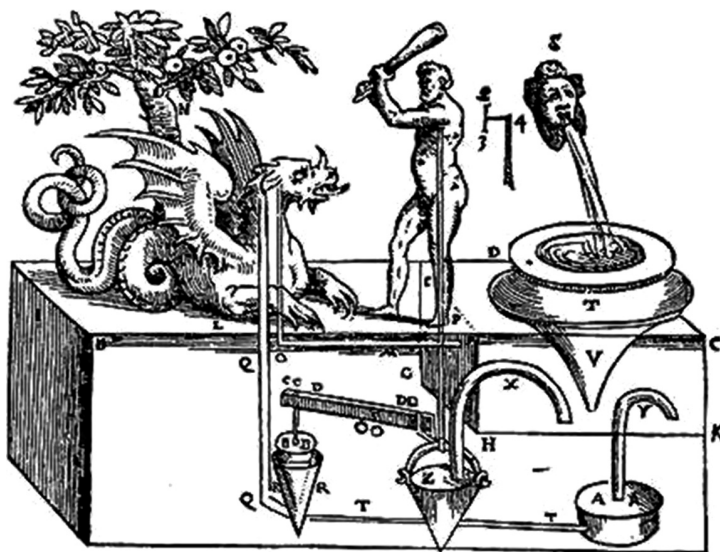
Fig. 3 An automaton by Hero of Alexandria (Reconstruction made by Giovanni Battista Aleotti 1589) [1]

Fig. 4 An automaton by Al Jazaari [2]

Examples of "robots" in the late Middle Ages were the moving figures built to enrich the towers and the clocks of the churches. An extraordinary example is the mechanical cock found in the clock of the Strasbourg Cathedral, built in the 14th

Fig. 5 Modern
reconstruction of the Japanese
tea maidservant automaton
[20]

century (Fig. 6): at the stroke of noon, the cock came out of a door, opened his
beak, showed his tongue, beat its wings and uttered three times a loud crowing.

In the Renaissance, the Italian engineer Giovanni da Fontana (1395?–1454?) in
his *Bellicorum Instrumentorum Liber* ("Book on war devices") described and drew
several automata to be used to throw arrows or bombs against enemies [7].

The first documented project of a programmable humanoid robot was made by
Leonardo da Vinci (1452–1519) around 1495. Some notes by Leonardo, redis-
covered in the 1950s, contain detailed drawings for the construction of a mechanic
knight, who was apparently able to stand up, wave his arms and move his head and
jaw (Fig. 7). It is not known whether the project, which was probably based on
anatomical research culminating in the famous Vitruvian Man, was ever imple-
mented by Leonardo. More details may be found in [21].

Later in the 16th century, the German mathematician and astronomer
Regiomontanus (Johannes Mueller von Koenigsberg, 1436–1476) designed and
built an artificial iron fly and an iron eagle that could fly [23]. In England, a wooden
beetle capable of flying was designed by the astronomer John Dee (1527–1608)
[10].

Before the 18th century, the limited development of mechanical technology did
not allow to build real robotic devices, so most of the "robots" found their place
only on paper, not in the real world. However, over the centuries the techniques for
metal processing greatly improved, thus increasing the accuracy of precision
mechanisms. Such progress in the mechanical technology enabled inventors to
build real anthropomorphic automata.

Fig. 6 The mechanical cock that used to be in the clock of Strasbourg's cathedral, now at the Musée des arts décoratifs de la ville de Strasbourg (*source* Wikimedia Commons)

In 1738 Jacques de Vaucanson (1709–1782) built a mechanical duck that could eat, drink, squawk and eject the waste products (Fig. 8). The duck wings, alone, contained a large number of moving parts: about 400. De Vaucanson also built two musicians robots: a drum player and a flute player. The latter could play the flute through a system of pipes that carried to the instrument an air flow coming from a bellows. More details about de Vaucanson's life and work may be found in [9].

Between 1770 and 1773 two Swiss brothers, Pierre (1721–1790) and Henri-Louis (1752–1791) Jaquet-Droz, built three impressive humanoid automata: a scribe, a draftsman and a musician (Fig. 9). The scribe was able to write letters with up to 40 characters and, by replacing a disk, could write different types of text. The draftsman could perform various types of drawings: from the portrait of Louis XV to a ship with its sails. The musician android was a 16 years old girl, who
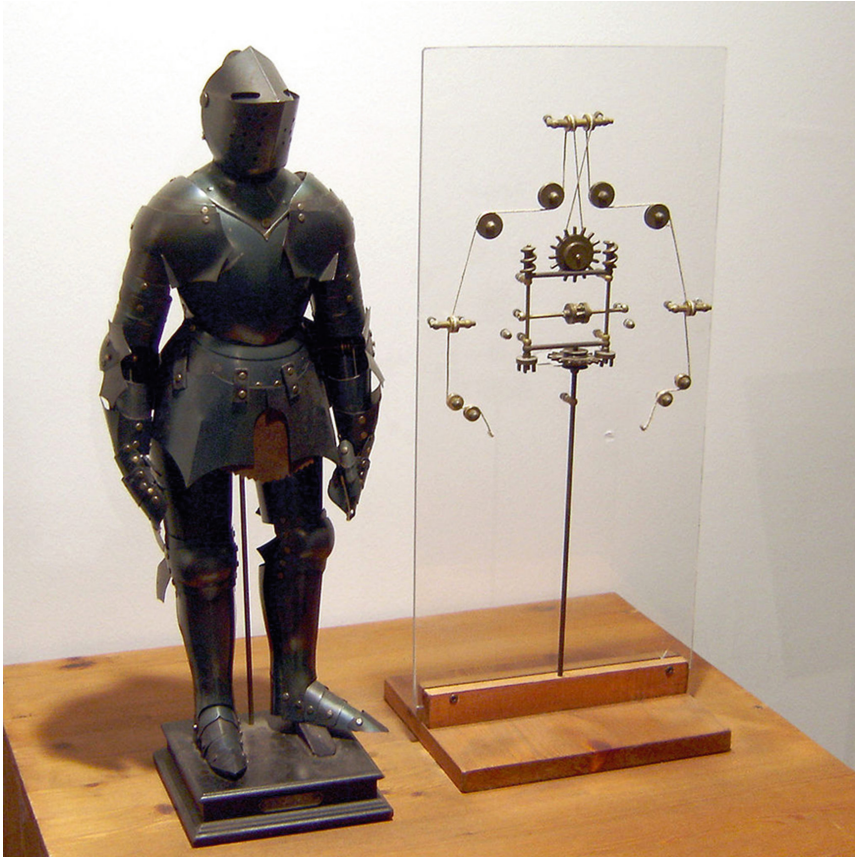
Fig. 7 Reproduction of Leonardo Da Vinci's knight and his internal mechanisms at the "Leonardo da Vinci. Mensch—Erfinder—Genie" exhibit, Berlin 2005 (*source* Wikimedia Commons)

was able to play an organ mimicking even the pauses and bowing at the end of the exhibition. These robots are still working and are located in the Musée d'Art and d'Histoire in Neuchâtel (Switzerland). More details about the Jaquet-Droz brothers and their automata may be found in [19].

The 18th century therefore appears as a time of extraordinary results in the field of Robotics. Until that time, all the automata were made by ingenious inventors mainly for pleasure. The following century saw the consolidation of the Industrial Revolution, and all the energies of inventors were devoted to the design and the development of devices that could increase the industrial production (for instance, the programmable loom invented by Joseph-Marie Jacquard in 1801), or to the mass production of automata, such as the thousands of clockwork singing birds that were built and exported all around the world by many small family-based automata makers living in Paris in the years 1848–1914 (this period was therefore named by
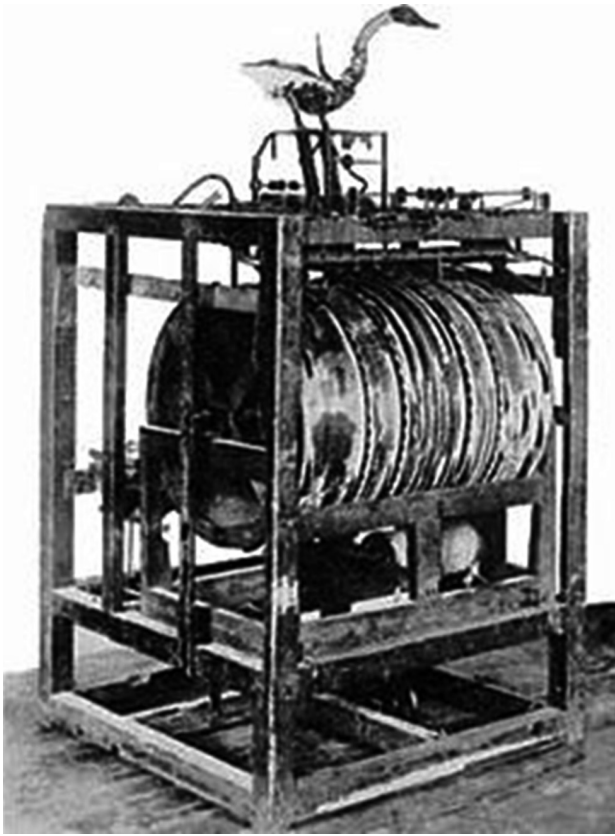
Fig. 8 The original De Vaucanson's duck at Musée des Automates de Grenoble, destroyed in a fire in 1879 (*source* Wikimedia Commons)

Bailly "the golden age of automata") [3]. In this sense, the 18th century marks the end of the amateur times of Robotics: from then on, the industrial and commercial needs became the main driving forces for the development in that field.

Later on, the 20th century can be considered the time when electronics starts to be widely employed in Robotics. Besides that, in that century scientists begin to think of building machines that could not only perform a mechanical repetition of the movements of a human being, but could also make decisions, being provided with memory and criteria for choosing. In other words, the history of humanoid Robotics in the 20th century is connected with the history of Electronics, Computer Science and Artificial Intelligence.

Fig. 9 Jaquet-Droz's automata at the Musée d'Art et d'Histoire de Neuchâtel (*source* Wikimedia Commons)

4   Conclusions

This paper dealt with a brief history of Robotics, from ancient times to the Industrial Revolution (18th century). The idea of artificial beings that could substitute real individuals to carry out heavy or repetitive tasks dates back to ancient times. Many legends among different civilizations, from ancient Egypt to the Renaissance, have been described. Thanks to the development of mechanical technologies, inventors could build devices that one could previously just imagine: several of such devices have been described in this paper. The historical outlook extends up to the 18th century, i.e. to the end of what we may consider the amateur era of Robotics.

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