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The ancient world was more technologically advanced than most of us realize. Its denizens' engineering skills were particularly notable, as we know from myths, literature written by ancient engineers, and, in some cases, technical artifacts that, miraculously, have survived thousands of years. The idea of creating artificial humanoids is persistent in classical myths and tales, and speaks to a cultural anxiety of intellectual and scientific risks. In turn, those stories correspond to, and perhaps even derive from, the achievements of technical experts in the ancient world. This essay discusses ancient tales of various world cultures that concern the invention of artificial humanoids, and then it considers the inventions and inventors that may have inspired the development of robots and automata.

The idea of creating an artificial human, or what we would call an android, is surprisingly old and appears in a number of ancient cultures. In ancient China, for instance, there is a story from the *Lieh Tzu*—a book most likely written in the third century BCE by Lieh Yü-Khou—that tells of an ingenious artisan named Yen Shih, who appears before a king with a lifelike automaton. The king asks the artisan who it is that he has brought, and a strange story unfolds:

> "That, Sir," replied Yen Shih, "is my own handiwork. He can sing and he can act." The king stared at the figure in astonishment. It walked with rapid strides, moving its head up and down, so that anyone would have taken it for a live human being. The artificer touched its chin, and it began singing, perfectly in tune. He touched its hand and it began posturing, keeping perfect time. . . . The king, looking on with his favourite concubine and other beauties, could hardly persuade himself that it was not real. As the performance was drawing to an end, the robot winked its eye and made advances to the ladies in attendance, whereupon the king became incensed

> and would have had Yen Shih executed on the spot had not the latter, in mortal fear, instantly taken the robot to pieces to let him see what it really was. And, indeed, it turned out to be only a construction of leather, wood, glue and lacquer, variously coloured white, black, red and blue. Examining it closely, the king found all the internal organs complete—liver, gall, heart, lungs, spleen, kidneys, stomach and intestines; and over these again, muscles, bones and limbs with their joints, skin, teeth and hair, all of them artificial. Not a part but was fashioned with the utmost nicety and skill; and when it was put together again, the figure presented the same appearance as when first brought in. The king tried the effect of taking away the heart, and found that the mouth could no longer speak; he took away the liver and the eyes could no longer see; he took away the kidneys and the legs lost their power of locomotion. The king was delighted. (Ronan 92)

A similar story from about the same time in ancient India tells of a female android. According to this account:

> There was once a knowledgeable artisan in the North of India who was an ingenious woodworker. So it came to pass that he made a woman out of wood. She was a beauty without equal. With her silk clothing and sash, and her magnificent adornments she was not in any way different from a real woman; she could come and go under her own power, and could also serve wine and make eye contact with those she served. All she lacked was the power of speech. (Chapuis, *Les automates* 18–20; translation mine.)

This android's maker decides to test his creation by playing a joke on a fellow artist. He invites the painter to his house for dinner and has his lovely artificial woman serve them wine. The painter is immediately stricken with desire for what he thinks is a beautiful maiden. But when he tries to hold her hand, he realizes with great alarm that she is made of wood. Enraged at the joke, he tries to take revenge on his friend by painting a realistic portrait of himself lying murdered on his bed. After trading such tricks back and forth, the two men decide that

the entire world is deceitful, and they swear off worldly pursuits to become monks.

These tales most likely derive from older Greek and Egyptian accounts of living statues and artificial humans, transmitted via trade with the Far East during the Hellenistic period (Needham 157; Chapuis, *Automata* 18). Indeed, there are many Greek stories of androids that predate the previously noted Chinese and Indian stories. *The Iliad*, which dates from about one thousand years before the earliest Chinese account, contains the most ancient literary reference to the creation of artificial humans. In book 18, Homer tells us of artificial serving girls forged by Hephaestus from solid gold. These maidens are no mere mechanical devices: "In them is understanding in their hearts, and in them speech and strength, and they know cunning handiwork by gift of the immortal gods" (419–21). In addition to these attributes, they possess considerable strength, as one of their common duties is to help support the god Hephaestus when he walks. When Thetis visits Hephaestus, he takes up his staff to walk across the hall, and his maids "busily moved to support their lord, and he, limping nigh to where Thetis was, sat him down upon a shining chair" (422–23). This part of *The Iliad* is not only a precursor to Indian and Chinese tales, for it is reflected in a later report of Indian androids by the Greek traveler and philosopher Apollonius of Tyana, who lived in the first century CE. Philostratus recounts that Apollonius of Tyana attended a feast in India where he saw "cup-bearers of dark bronze resembling the figures of Ganymede or of Pelops among the Greeks," figures who "mixed wine and water in due proportion, and carried the goblets about as at a wine party" (78, 81).

The devices described in Philostratus's account strongly resemble those in other Greek stories, which predate similar stories from the Far East. Daedalus, for example—who famously made wings so that he and his son could escape imprisonment on the island of Crete—was believed widely to have created not only the labyrinth that held the half-man, half-bull creature the Minotaur but also self-moving

human statues. Aristotle and Plato mention these moving statues in various works. Aristotle's reference is the most specific; he notes that Daedalus's wooden statue of Aphrodite purportedly was animated by mercury, which was thought at the time to be a living substance (*On the Soul*, 406b, 19–20). Aristotle also refers to Daedalus's moving statues in his *Politics* (1253b). In Plato's *Meno*, Socrates mentions that Daedalus's statues would "run away" unless they were fastened to the ground (97d), and in *Euthyphro* Plato has Socrates make an implicit comparison between these statues and the way his opponent's arguments wander (11b-d).

Legends concerning Talos, the giant metal man made by Hephaestus and given to Minos, the King of Crete, relate that the creature guards the king's land from invaders. Talos also appears in the work of various ancient Greek authors, most famously in the *The Library* (bk. 1, ch. 9, sec. 26) attributed to Apollodorus of Athens, and in the *Argonautica* by Apollonius of Rhodes, in which the giant metal man attacks Jason and his Argonauts, tossing huge boulders at their ships to keep them away from the shore (bk. 4, sec. 1638). Depending on the version of the myth, Talos defends Crete by throwing rocks, as in the *Argonautica,* or by picking ships out of the water, holding them to his chest, and heating up his metal frame until they burst into flames. Talos is made of brass and almost indestructible. His only vulnerability is his ankle, where a pipe carries life-giving fluid and runs close to his metal skin. In some versions, the metal man is destroyed when his ankle is punctured in some way and the fluid, called ichor, drains away. This legend is among the most enduring Greek legends about artificial men, and Talos reappears in such later tales as Edmund Spenser's Renaissance poem *The Faerie Queene* (1590, 1596) and Herman Melville's "The Bell Tower" (1855).

Ancient Greek poet Pindar explains that the artists of Rhodes were so skilled that their statues could be seen walking the streets of the city (*Olympian Odes* sec. 7, 53). Similar to Pindar's assertions, the myth of Pygmalion, as related in book 10 of Ovid's *Metamorphoses*, tells the

story of an artist and the King of Crete who sculpted a statue of a woman so lifelike and beautiful that he fell in love with it. Aphrodite sees his unrequited yearning, takes pity on him, and animates the statue, which becomes the lady Galatea.

Finally, the major Greek accounts concerning artificial humans would not be complete without the myth of the Titan Prometheus's creation of humankind out of wet clay. There is evidence that Plato's student Heraklides was the first to have written about the Prometheus myth as a story of human origins, but by the fourth century BCE the myth was fairly common. Ovid's account of Prometheus is probably the most famous and appears in the first book of his *Metamorphoses*, three hundred years after Heraklides's account (Wutrich 49).

Many Greek stories feature gods or demigods making artificial androids, and such humans as Daedalus, who build similar creatures, are godlike in the power of their knowledge: Daedalus's moving statues are, with the exception of their material, much like the ones made by the god Hephaestus in *The Iliad*, and the invention of wings allows Daedalus the power of flight previously reserved for beings like the sun god Apollo. As is evident in the various works that follow, the theme of human ingenuity is repeated throughout history, in stories concerning artificial androids and their creators. In this way, the artificial servant that derives from ancient tales becomes an emblem of the fears surrounding intellectual and scientific risks.

Tales that connect godlike powers with androids also were present in ancient Egypt. Unlike ancient Greek myths, however, some Egyptian stories that originated before 300 BCE appear to be historical accounts of real artifacts, and this may have influenced the Greek engineers based in Alexandria, Egypt, who built actual androids. Philostratus, Pliny, Juvenal, Strabo, and Tacitus each mention a statue of Amenhotep III at Thebes (the Greeks later renamed the statue Memnon) that was widely thought to be able to talk. In fact, according to the sources mentioned above, this statue made a sharp sound after

dawn that sounded like the breaking of a harp string (Cohen 16). The stone figure was one of two identical statues of the pharaoh built side by side, facing east, and carved from single blocks of stone. According to the ancient Greek historian Strabo, the northernmost statue of the pair, which still attracts tourists, was damaged in an earthquake, which caused the torso and head of the statue to topple. Though Strabo expressed some skepticism about where the sound originated from, there were many others who heard the sound emanate from the base of the broken figure (Strabo 123–24). A basic knowledge of modern physics makes this story credible, since the sudden heating of a broken stone in a hot, dry climate could produce sufficient pressure along small fissures to make a high-pitched sound. This explanation is supported by reports indicating that when Roman Emperor Septimius Severus had the two halves of the statue put back together in 199 CE, the sounds stopped (Platnauer 123).

Also at Thebes, the Egyptian priests created statues that could give the appearance of speech and movement. One modern archeologist's description of an ancient talking statue provides insight into how these devices worked:

> in 1936, Loukianoff published an article on his recent discovery of a fairly large bust in white chalk or limestone of the god Re-Harmakis, coming from Lower Egypt. This bust, which may be seen today in the Cairo museum, has an oval cavity hollowed out in the back of the neck. From this cavity on the right-hand side a narrow canal leads to a small oval-shaped opening just under the god's right ear. This cannot be seen when the statue is looked at from the front. 'If,' says Loukianoff, 'the priest who was behind the statue, hidden by the great halo crowning it, and by the body of the statue, and so invisible to everyone, approached the mouth of the cavity and spoke, his voice became modified in the tube (Loukianoff himself proved this) and resounded, giving the impression that it was the statue which spoke.'" (Chapuis and Droz 16)

Similar clever mechanical tricks, like those used to create the illusion of speech, were used to give the arms and head an appearance of independent motion. During the late Ramses dynasty, around 1100 BCE, the priests of the god Ammon had become so powerful that they chose the pharaohs. In the city of Napata, the priests created a statue of their god that had limited powers of movement and speech, and they used it as a key instrument in their ceremonies for making coronation decisions. To choose a new ruler, "All the males of the royal family were made to pass in front of it, and the statue would stretch out its arm to seize one of them, while at the same time delivering an exhortation to him" (Chapuis and Droz 14–15).

A fair number of Egyptian records and some material evidence of automata (nondigital robots run by mechanical means, such as clockwork gears or steam) reveal how Egyptian automata might have functioned. The most abundant evidence of human automata dates from the period in which the Greeks controlled Egypt. Starting with Ctesibius, a group of very talented engineers arose at Alexandria after Alexander the Great's conquest of Egypt. Ctesibius and his followers had great technical and engineering skills and left behind documents that detailed automata powered by hydraulics and steam. He is most famous for his use of hydraulics and pneumatics (forced air) in creating marvelous devices, such as the suction pump, a water clock (clepsydra), and a water-powered pipe organ (hydraulis). None of his written work survives, but Ctesibius, his writing, and his inventions are mentioned by other notable ancient engineers, including Vitruvius, Athenaeus, Philo of Byzantium, and Hero of Alexandria (Lahanas).

Additionally, remains of an organ made in the first century BCE using Ctesibius's earlier designs were discovered in Dion, Greece, by archeologists in 1992, and a team of scientists subsequently was able to reconstruct a working model. Ctesibius also built human automata. As in previous times, these devices often were connected with religious and civil ceremonies; because Egyptian rulers were regarded as deities, religious and civil ceremonies were typically synonymous.

For instance, Ctesibius made a moving statue for a famous ceremony called the Grand Procession of King Ptolemy Philadelphus. This automaton was operated by curved wheels (called cams) mounted on rotating shafts that cause variable movement in connected parts. These cams enabled the figure to alternately stand and sit when moved on a platform through the streets (White). Ctesibius also decorated his water clocks with small moving figurines operated by gears attached to the clock (Lahanas).

Philo of Byzantium, one of Ctesibius's students, not only continued his mentor's groundbreaking work on pneumatics and hydraulics but made human automata as well. One of his most famous mechanical devices is a figure of a small girl pouring water. In *Pneumatica*, Philo also describes how to make automated theaters that incorporate human automata (16). This kind of mechanism, which is described later by Hero of Alexandria, is essentially a puppet theater in which figurines and stage sets move by mechanical means. Hero—or Heron, the last of the great Alexandrian engineers—describes how to make the simplest type of this theater in his treatise *Pneumatics*. One fashions little figurines of dancers and puts them on a circular wooden platform. This platform is enclosed on all sides in a glass cylinder or transparent horn. On the top of the cylinder is a small receptacle where a fire can be built; a hollow metal tube runs from the bottom of this little altar to the middle of the platform. Hollow metal spokes connect from the base of this pipe outward and curve ninety degrees at their ends, pointing in the same direction so that each spoke-end acts like a jet for the hot air that is forced from the altar. In this way, the hot air is forced against the sides of the glass cylinder, propelling the platform and the dancers in a circle.

In *Automatopoietike*, Hero describes a number of more complex automatic theaters—run mostly by pulleys, weights, and rope. Such theaters have more variety of movement than the previous example, and their various moving parts convey a little tale. One, for instance, tells the tale of Nauplius in the aftermath of the Trojan War. This theater

features doors that open and close by themselves, as well as a series of nine two-dimensional tableaus, including a scene with moving nymphs that saw wood to build ships. Then the completed model ships appear to be moving on the sea, and model dolphins jump out of the ocean around them (James and Thorpe 137).

The most interesting of Hero's human automata are those that combine hydraulics and the mechanical devices of the automatic theaters to create a closer resemblance of lifelike action. One hydraulic machine incorporates a statue of Hercules (Hero 62), in which a person lifts a miniature apple and the machine shoots an arrow at a dragon, which then hisses. This illusion operates partly by mechanics: when the little apple lifts off the pedestal to which the whole scene is attached, a chain attached to a trigger mechanism in Hercules' arm releases the taut bowstring, shooting the arrow at a dragon on the other end of the pedestal. The same chain is attached to a plug inside the pedestal that lifts with the apple and allows water to run from an upper chamber to a lower one. Next, flowing water forces air from the lower chamber into a narrow metal tube that extends into the dragon's mouth. This airflow produces a hissing sound until the apple is replaced, stopping the flow of water and air.

Although none of Hero's automata survive, a number have been recreated from his detailed written descriptions and work perfectly. One recreation of a self-moving stand would have been used for one of Hero's automatic theaters. Constructed by Sheila M. Kyte, a student at Smith College, this self-moving container is exhibited in the college's Museum of Ancient Inventions. Fashioned according to Hero's description, the stand operates by means of a heavy weight attached to wheels inside the stand. The weight rests in a box of sand that drains at a measured rate into a compartment underneath. As the sand-level goes down, the weight pulls the ropes that turn the wheels. The stand moves on its own for a period of time that depends on the amount of sand inside. In Hero's theaters, ropes also moved various gears, which would power the human figures and the scenery within.

Replicas of Hero's devices have been made using computer modeling or computer animation programs. One fascinating mechanism automatically opens a temple door when a fire is lit on a nearby altar (Hero 59). The whole temple and altar sit above a hollowed area, or pedestal, under which is an elaborate apparatus. The heat of the fire forces air down a metal tube attached to the bottom of the altar and into a sealed container that is partly filled with water. The hot air raises the pressure inside of this container, pushing water through a lower tube and into a bucket suspended by chains. The chains, connected to the two extra long cylindrical hinges that extend into the space underneath the temple doors, tighten and turn those hinges when the bucket fills with water. A weight is attached to other chains wrapped counter to those that are positioned around the hinges, and when the fire is extinguished, the natural vacuum causes the water to siphon back into it. This lightens the bucket and allows the weights to pull the doors closed.

Perhaps the oldest surviving example of ancient automata is a mysterious technical marvel called the Antikythera mechanism, which was found in the early twentieth century by Greek sponge divers. In 1900, just off the coast of the island Antikythera, Elias Stadiatos, one of nine sponge divers working about 100 feet off the coast of the island, stumbled upon the wreck of an ancient Greek merchant ship on the floor of the Mediterranean Sea. The vessel, which sank about 80 BCE, lay more than 140 feet under the surface and contained statues, wine vessels, and other cargo that gave a snapshot of Greek life at the time. Among the artifacts, divers found several metal gears encrusted in a rocky mass of barnacles and sea debris. The gears that remained visible sat within a wooden frame. The wood rapidly disintegrated after the artifact was brought to the surface, but the mysterious protruding gear survived and remained a puzzle for many years, as there was no way for early twentieth-century scientists to separate the rock from the old metal without destroying it.

In the early 1970s, Derek J. de Solla Price, a noted science historian, had a colleague use x-ray scans and metallurgical tests to examine

more of the rock's interior. Through these tests, he determined that the whole was a complex mechanism comprising thirty-two interlocking gears, and posited a model for how the mechanism functioned (Price). After Price died in 1983, his studies were developed further by such successors as Michael Wright, the curator of mechanical engineering at the Science Museum of London. Using a newer form of x-ray technology called linear tomography, which can reveal views of an object layer by layer, he verified Price's theory and corrected some errors he had made (Marchant). The work pioneered by Price and Wright continues today, with researchers trying to determine from where the artifact came and for whom it was made. The most notable current investigators are those associated with the Antikythera Mechanism Research Project. Since Price's initial discoveries, researchers have agreed that the device was most likely an analog computer used by the Greeks to calculate the position of the sun and the planets. One simply had to turn a handle and the intricate clockwork gears would make the necessary calculations, producing a result on dials positioned on the front of the wooden box. This automatic device proved Greek technical expertise and demonstrated that references to similar devices by writers like Cicero (bk. 2, sec. 34) and Vitruvius (bk. 9, ch. 8, sec. 4–7) were not merely theory or rumor. Additionally, it shows that Hero could have made the automata he described.

Alexandrian scientists Ctesibius, Philo, and Hero are important not only because their devices provide clues to the workings of the moving statues of ancient Egypt, but also because their inventions reveal the two primary motivations for their creation. Automata were mainly toys for the wealthy and tools for the priests. Inventions such as Ctesibius's hydraulis or Hero's "Hercules Shooting a Dragon" were amusements for those wealthy enough to commission their construction. They were also symbols of power, their magnificent designs conveying the status of their owners. The operation of these inventions likely instilled in observers a reverence for their makers' command of nature, and in this way automata were important tools for Egypt's priests; the

enhancement of power was the main aim of mechanisms devised for religious purposes. The early Egyptians' talking and moving statues, Hero's self-opening temple doors, and even a coin-operated holy water dispenser—which Hero designed for use in a temple—were not just toys. They were instruments meant to transfix the crowds and increase the priests' control of worshipers. Because the observers of these devices knew nothing of their hidden mechanisms, they assumed that their owners possessed godlike knowledge. In some examples, such as the moving statue of the priests of Ammon, the automata contributed a supernatural aspect to their role and augmented the power of the priestly elite. This relationship between automata and power would prove persistent over time, growing into a preoccupation with marvels (*mirabilia*) during the Middle Ages and Renaissance.

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