

◆ CHAPTER 4 ◆

BEYOND NATURE

ENHANCED POWERS BORROWED FROM GODS AND ANIMALS

HOW DID HUMANS come to be weaker and more vulnerable than wild beasts? As Plato recounted the story, human beings were stinted because it was left to a committee of two to distribute the abilities of earthly creatures (*Protagoras* 320c–322b). After the creation of humans and animals, the gods put two Titans, Prometheus and his younger brother Epimetheus, in charge of allocating capabilities. Epimetheus (“Afterthought”) was not as wise as his brother Prometheus (“Forethought”). Epimetheus begged to have the privilege of assigning various powers, promising that Prometheus could then inspect his work.

Epimetheus began sorting out the natures of animals of land, sea, and sky. He was so absorbed in the task of ensuring their survival, with gifts of speed, strength, agility, camouflage, fur, feathers, scales, keen eyesight and hearing, superb sense of smell, wings, fangs, venoms, talons, hooves, and horns, that he absentmindedly used up all the abilities on nonreasoning creatures. With a start, he realized that there was nothing left for the naked, defenseless humans, just as his brother Prometheus arrived to inspect the creatures—and on the very day they were destined to emerge on earth.¹

“Desperate to find some means of survival for the human race,” Prometheus stole the powers of technical skills, speech, and fire from the gods to bestow on the weak mortals, so that the men and women could at least make tools and figure out how to compensate for their pitiful capabilities. As Brett Rogers and Benjamin Stevens point out in their comparative study of classical Greco-Roman literature and modern science

fiction, the myth of Prometheus can be read as an early “explanatory account and as a symbol for the ongoing human relationship to technology,” an example of “speculative fiction” conceived by an ancient culture not usually seen as “techno-scientific.” The gifts bestowed by Prometheus represent the first “human enhancements,” defined as “attempts to temporarily or permanently overcome limitations of the human body by natural or artificial means.”²

As the Greek myth tells us, Zeus sentenced Prometheus to perpetual pain, commanding his Eagle to devour the Titan’s liver every day. But the Titan’s gifts to humanity keep on giving, with potential for both positive and worrisome ramifications. “Technology makes up for our absurd frailty,” comments Patrick Lin, a philosopher who studies the ethics of robotics, AI, and human enhancement technologies (HET). “We naked apes couldn’t survive at all if it weren’t for our tool-making intellect and resourcefulness.” Today, human enhancements such as visual and hearing aids, titanium joints, pacemakers, stimulants, and bionic prosthetics are commonplace and welcomed.³ But controversies arise over some human improvements and supernatural enhancements slated for questionable uses. People start to worry when, for example, military scientists seek to make soldiers “more than human” through drugs, implants, exoskeletons like the TALOS project (chapter 1), human-machine hybrids, neurorobotics, and by replicating the enviable powers of animals. As Lin and his colleagues warn, multiple practical and moral risks swarm around modern attempts to “upgrade” the bodies of humans and to develop augmented soldiers, military androids, cyborg creatures, drones, and robot-AI auxiliaries.⁴ By now, it will come as no surprise that the outlines of some of those quandaries were foreshadowed in ancient Greek times.

Techne combined with intellect and audacity—these are the unique gifts that human beings rely on to survive in the world. This ancient Greek understanding was beautifully summarized by the playwright Sophocles (*Antigone* 332–71). “Humans are formidable,” declared Sophocles, for no other creatures have the skills and daring to navigate the stormy seas, plow the earth, tame horses and oxen, hunt and fish, devise laws and make war, and build and rule cities; no other creatures have the facilities of language and “wind-swift thought” of “all-resourceful” humans, ceaselessly contriving ways to escape the forces of nature. “Skillful beyond

hope is the contrivance of humans' inventive arts (*mechanoen technas*) which advances them sometimes to evil and other times to good.”⁵

In the myths about Medea, Jason, and the legendary inventor Daedalus we find the earliest records of how humans desired to exceed and augment human powers, to create unnatural forms of life, and to harness artificial beings—including animal replicas. As we have seen, Prometheus suffers eternal punishment for giving mortals tools and fire, and Tantalus pays forever for stealing ambrosia for humans. Now, let us take a look at another myth of human enhancement, in which the cunning wizard Medea manages to make off with a quantity of divine ichor, to help Jason defend himself against superior deadly forces.



In the ongoing escapades of the Argonauts, Medea mixes a potion and devises a clever tactic to protect Jason from her father’s fire-breathing brazen bulls and an army of unnatural soldiers that arise from dragon’s teeth. In search of ultrapowerful *pharmaka* for her lover, Medea treks to the high Caucasus Mountains, to the rocky crag where Zeus had chained Prometheus. Medea knows that a rare flowering plant grows in the soil wherever precious ichor drips from Prometheus’s side as the Eagle ravages him. When they are cut, the strange plant’s flesh-like roots ooze a black sap containing the essence of the immortal Titan’s ichor. Medea collects the sap in a pure white shell from the Caspian Sea and compounds a potent drug. Known as “Promethean,” the ointment imparts superhuman powers, deflects fire, and resists enemy spears. The effects of the ichor-drug are spectacular, but temporary, lasting only one day.⁶

In the *Argonautica*, the Promethean ichor preparation gives the normally passive Jason incredible Herculean strength and courage. As Medea promised, Jason suddenly feels “unbounded valor and great might like that of the immortal gods.” As the drug begins to circulate, he senses “terrifying powers entering his body.” His arms begin to twitch and flex, his hands clenching at his sides. Like a warhorse eager for battle, Jason “exults in the superhuman strength of his limbs.” Under the influence of the ichor coursing through his body, Jason “strides and leaps about, brandishing his spear and roaring like a wild beast.”⁷



FIG. 4.1. Prometheus bleeding ichor on the ground, as Zeus's Eagle pecks his liver. Laconian cup, sixth century BC. Vatican Museum. Album / Art Resource, NY.

The effects of the drug as described in the *Argonautica* put one in mind of synthetic psychoactive stimulants: for example, modern street drugs chemically related to but much stronger than cathinone from *qat* plants which can cause users to feel that they have superhuman strength and goad them into ferocious acts. Today's military pharmacologists are creating "human enhancement" concoctions that could supercharge soldiers mentally and physically, making them behave much like Jason under the influence of the Promethean ichor. Millennia ago in Homer's *Odyssey* (4.219–21), Helen of Troy mixed an elixir called nepenthe, imagined as opium and wine, to dispel the traumatic memories, "anger, and grief" of the shell-shocked veterans of the Trojan War. Now military scientists seek drugs and other neurotechnological brain interventions that would allow troops to go without sleep, sense no physical pain, exceed normal

aggression, override moral qualms about killing or torture, erase negative thoughts, and obliterate memories of wartime violence or atrocities.⁸



Returning to the myth of the Golden Fleece, we witness how Medea's Promethean drug lends Jason the physical and mental power to wrangle the pair of bronze robo-bulls that were forged for King Aeetes by the smith god Hephaestus. Aeetes commanded Jason to plow a field with these fire-breathing bulls, plant a helmet-full of dragon's teeth, and then defeat the invincible army that would arise from these sown dragon "seeds," all before sunset. The king is confident that even if Jason somehow manages to avoid being burned to death and plants the teeth, he and his men will be destroyed by the unstoppable automaton warriors that will spring up from the field.

At dawn, the fearsome bulls emerge from their sooty underground stalls, pawing the ground with their brazen hooves. They charge at Jason, flames shooting from their nostrils "as though blasted by bellows from a bronze-smith's furnace." Jason braves the searing breath of the oxen and yokes them to the bronze plow. All day he plows the large field and sows the dragon's teeth.⁹

It is nearly dusk when the plowed furrows begin to seethe and gleam as the "earthborn" warriors in armor sprout from the field. This is the horrid crop of robot-like soldiers that must be "harvested," cut down, before nightfall. The scene of skeleton soldiers popping out of the ground is beloved by aficionados of science fiction and classical mythology film, as it was realized in the spectacular Harryhausen sequence in *Jason and the Argonauts* (1963).

In the *Argonautica*, the "earthborn" warriors are ghostly giants clad in bronze armor, springing up fully armed, ready to attack. Luckily, Medea has instructed Jason how to deal with the multiplying, uncontrollable mob. The earthborn soldiers lack one crucial attribute: they cannot be ordered or led, nor can they retreat. They are hardwired to advance and attack. With continuous reinforcements swelling their ranks, the armed androids march on the nearest "enemy"—Jason's men.

Just as Medea figured out how to incapacitate the bronze robot Talos of Crete by exploiting his internal mechanical weakness and "almost

human” artificial intelligence, she now takes advantage of the coding imprinted in the sown army. Medea advises Jason to toss a stone to trigger the soldiers’ programming. She realizes that a random impact will initiate a domino effect, a cascade of blows, causing each android to fight the nearest soldier and thereby destroy each other.

As the first ranks of the dreadful army begin to advance toward the Argonauts, Jason throws a boulder into their midst. Sensing the blows striking their bronze armor, the androids react as though attacked. They turn on each other in confused frenzy, hacking at each other with their swords. Then Jason and his companions rush into the fray and finish them off, including some emerging warriors still half-rooted in the plowed furrows.¹⁰

Recounting this myth more than two thousand years ago, the skeptic Palaephatus (*3 Spartoi*) remarked, “If this story were true, every general would cultivate a field like Jason’s!” But the story’s dilemma maintains its edge today. How can automaton soldiers distinguish friend from enemy? They could easily turn on each other or on one’s allies. How can their orders be recalled or revised? The archaic tale, which some scholars believe predates Homer, is one of the earliest observations that cyborg or robot soldiers will bring problems of command and control.¹¹



The fire-breathing bronze bulls recall the abilities of Talos of Crete, who could heat his brazen body red-hot to roast adversaries (chapter 1). Heated bronze animated statues also bear similarities to some later lore about Alexander the Great. Among the many legends about his military inventions in the *Alexander Romance* traditions, two stand out for deploying fiery bronze statues against enemies. In the first, from the Byzantine-era *Greek Romance*, Alexander devises a strategy to counter the great war elephants of King Porus of India. He heaps onto a large fire all the lifelike bronze statues taken as booty in his conquests. Then his men carefully set out the red-hot statues as their front line on the battlefield. When Porus sends forth his war elephants to attack, the beasts take the bronze men for live soldiers. They crash into the heated metal statues and are badly burned.¹²

The second example presents a more technologically sophisticated version of fire-breathing bulls. In Persian legends that arose about Alexander, the young warlord Sikandar (Iskandar, Alexander) devises an iron cavalry to defeat the army of King Fur of Hind (Porus of India). In some Persian traditions, Alexander is advised by his grand vizier, the sage Arastu (Aristotle, Alexander's tutor). In Firdowi's epic *Shahnama* (14–15; written in about AD 977, based on earlier oral stories), Alexander's spies make wax scale models of Porus's war elephants to convey how huge and terrifying these unfamiliar beasts are. Alexander then comes up with a battle plan. He commands twelve hundred Greek, Persian, and Egyptian master ironsmiths to forge a thousand life-size hollow iron statues of riders and horses. It takes them a month of painstaking work. The replica horsemen are painted realistically, attached with rivets to saddles, and fitted with armor, shields, and hollow spears. The horsemen's faces would resemble the uncanny, lifelike iron and bronze masks typically worn by Kipchak and other central Asian mounted warriors of the era, which frightened enemies with the impression of an army of metal soldiers. Alexander's craftsmen paint the iron steeds to look like real "dappled, chestnut, black, and gray" horses. The smiths fit the horses with wheels, and then, in the diabolical last touch, they fill the hollow iron figures with volatile naphtha collected from crude petroleum wells.

On the battlefield, Alexander's men ignite the naphtha and set the iron cavalry rolling toward the enemy. The eerie host of metal horses and metal riders, painted to generate the illusion of life, with orange flames shooting from the horses' nostrils and the ends of the riders' spears, create an intimidating juggernaut. Porus's burned elephants run amok; his army is routed. A dramatic color illustration of the spectacle appears in a medieval Mongol version of the *Shahnama*.¹³ The statues did not have moving parts but were wheeled like Pasiphae's notorious artificial cow (made by Daedalus, described below).

The iron cavalry evoked a convincing sense of reality mixed with unnatural firepower. The legend reflects practices used by historical Mongol and other nomad armies, who deployed naphtha-wielding cavalry and used the trick of setting dummy soldiers on live horses to make their armies appear larger.¹⁴



Since antiquity, human augmentations and enhancements in the form of modern prosthetics have advanced to high levels, from implants, organ transplants, and replacement limbs to neurologically controlled artificial legs and arms. Replacement limbs and bionic body parts—the melding of human and machine—have deep roots in mythology and in actual history. In mythology, for example, the Celtic King Nuada (or Nudd) of the Silver Hand had an arm fashioned by the inventor god Dian Cecht. The Norse goddess Freyja was a kind of “organic cyborg” who combined both flesh and metal. In ancient Hindu epic traditions, the heroine Vishpala lost a leg in battle and Vadhrimati lost a hand—the gods replaced the body parts with, respectively, an iron and a gold replica. In ancient Greek myth, the god Hephaestus made an ivory scapula to replace the hero Pelops’s missing shoulder blade.¹⁵

The earliest historical record of a prosthetic body part was reported by Herodotus (9.37.1–4) in the fifth century BC. Hegesistratus, a Greek from Elis (southern Greece), lost part of his foot under torture by the Spartans. He managed to escape and had a wooden replacement made. He went on to fight in the Battle of Plataea (479 BC) on the Persian side, because of his hatred for the Spartans.¹⁶ Pliny (7.28.104–5) tells how M. Sergius Silus, a Roman veteran of the Second Punic War against Carthage (218–201 BC), recovered from twenty-three wounds and wore an iron hand to replace the one he had lost in battle. The Alexandrian author known as Dionysius Skytobrachion (“Leather-Arm,” fl. 150 BC) may have been so named because of a prosthetic arm.

Archaeological discoveries have unearthed surprisingly early evidence of artificial limbs and other body parts, some aesthetic and others functional. A skull from a site in France dated to 3000 BC, for example, sported a prosthetic ear carved from a shell. In Capua, Italy, a skeleton in a tomb of about 300 BC was fitted with a remarkably well-preserved wooden leg covered with thin sheets of bronze. Another skeleton from a grave of the same era, but in Kazakhstan, revealed that a young woman lived several years with a missing foot that had been replaced with the bones and hoof of a ram.¹⁷

Some of the most sophisticated prosthetic devices are the most ancient. In about 700 BC, a highly skilled artisan who understood human

biomechanics made a finely carved artificial toe for a woman whose mummy was discovered in 1997 near Luxor, Egypt. Her replacement toe was not only realistic in appearance; it was tailor-made for her foot and shows evidence of refittings. Worn barefoot or with sandals, her prosthetic toe allowed relatively comfortable mobility: it was constructed in three sections of wood and leather, with a hinge for flexibility.

An ocular prosthesis was discovered by archaeologists in the Burnt City site in Iran. The meticulously realistic artificial eyeball was embedded in the left eye socket of a woman who lived about forty-eight hundred years ago. The anatomical details are amazingly true to nature, with convex surface, cornea, and pupil, and the interior even contained extremely fine golden wires to mimic the capillary network of the eye. The eye was engraved with rays and covered in gold leaf, which would have given the woman an “incredibly striking visage” in life. It is noteworthy that modern attempts to create lifelike prosthetics inspired the robotics engineer Masahiro Mori to suggest the concept of the “Uncanny Valley” in 1970 (for definition and further discussion, see chapter 5 and glossary).¹⁸



Some ancient Greek myths tell of those who, like modern military scientists, dreamed of replicating the special powers of animals and birds to amplify human abilities. The artisan par excellence in ancient Greek traditions was Daedalus, the mastermind of facsimiles of life and biotechnological inventions. Since Homer, the word *daedala* denoted any work of marvelous art and workmanship, including those attributed to Daedalus. The chronology and geography of his vast résumé are inconsistent. For example, Pausanias (10.17.4) reported the belief that Daedalus had lived in the mythic “epoch when Oedipus was king of Thebes,” while others placed him in King Minos’s court about a century before the legendary Trojan War. Various tales locate workshops of Daedalus in Crete, Sicily, and Athens. The activities of the enigmatic, prolific, itinerant “first inventor” called Daedalus can be pieced together from an extensive body of literature and art. The figure of Daedalus takes on a collective persona as a mythic “hero” of invention, the “archetypal craftsman.” Was “Daedalus” based on a real person? Modern scholars consider the evolving traditions about Daedalus as attempts to reconcile the many

conflicting accounts—and as a reflection of the dual status of Daedalus as both a mythical character and a real historical innovator (or group of inventors) of the remote past.¹⁹

Unlike Medea's witchcraft that melded *biotechne* with sorcery, Daedalus's cunning devices and human enhancement schemes were achieved with no whiff of magic. Daedalus was a craftsman and inventor, not a magician. Using familiar tools, methods, techniques, and materials, Daedalus deployed creative expertise and technology to achieve wonderful results. Hyperrealistic sculptures, "living statues," were his specialty (chapter 5). But Daedalus is probably most famous for his human-powered flight with wings. And that endeavor started with a witch named Pasiphae. She was Medea's aunt and the wife of King Minos of Crete.



Queen Pasiphae cast a spell on her husband of a particularly foul nature: any time Minos attempted sex with another woman, he ejaculated scorpions, millipedes, and snakes.²⁰ In turn, Pasiphae was cursed by Zeus with an unnatural desire to have sex with a handsome bull in Minos's herds. She confessed her wish to Daedalus, the brilliant sculptor-craftsman in her husband's court. To fulfill Pasiphae's request, Daedalus constructed a wooden replica of a cow, hollow so that Pasiphae could crawl inside and present herself on all fours for the bull to mount.

This myth was first recounted in writing by the skeptic Palaephatus (fourth century BC) who raised several objections (*z Pasiphae*). His primary doubt was that a bull would be fooled by an artificial cow decoy, because bulls "smell the genitals of their mates before copulating." But other writers—Apollodorus (*Library* 3.1.4), Hyginus (*Fabulae* 40), and Philostratus (*Imagines* 1.16)—answered that objection, noting that Daedalus covered the wooden facsimile with the hide of a real cow from the herd in the pasture where the bull grazed, so that it appeared and smelled familiar. Modern animatronics experiments have demonstrated that a wide variety of mammals, from meerkats and monkeys to hippos, will interact socially with realistic robotic animals made with actual hides and anointed with species-specific scents. In classical antiquity, there were many anecdotes about paintings and replicas of fauna and flora so accurately rendered that they tricked animals into reacting as though they were alive.²¹

Ancient Greek sources tell of an interesting deception involving a troop of fake “war elephants” that looked and moved persuasively from afar, but failed to convince seasoned warhorses up close. The mastermind was the legendary Assyrian warrior queen Semiramis (probably based on the historical queen Shammuramat, ninth century BC); the story was first recounted by Ctesias (fifth century BC) and then by Diodorus Siculus (2.16–19; first century BC). The numbers are exaggerated but the ruse is plausible. Semiramis, facing a war against a superior Indian army equipped with thousands of war elephants and a strong horse cavalry, ordered her artisans and engineers to slaughter 300,000 black oxen and sew the hides into realistic elephant shapes stuffed with straw. It took two years for the craftsmen, working in a secret place, to manufacture the dummy elephant forms. The ox-hide elephant shapes were then placed over remarkably cooperative camels, and men sat inside to flap the ears and swing the trunks in naturalistic fashion. Semiramis expected to gain the advantage because the Indians believed that only their armies deployed elephants. Indeed, the Indian commander was taken aback to see the “multitude of war elephants” approaching the battlefield. His cavalry, being quite used to elephants, attacked boldly. But upon reaching the fake elephants, the horses shied and ran amok when they detected the unfamiliar odor of the hidden camels.

Several instances of realistic fake animals were reported by Athenaeus. He told of male dogs, pigeons, and geese that attempted to copulate with female replicas of their species. One example was a bronze cow so seductive that it was mounted by a real bull at Priene, a town on the coast of Asia Minor (Athenaeus *Learned Banqueters* 13.605–6).

The sensational myth of Pasiphae mating with a bull is one of several myths about biotechnology allowing humans do things beyond what ordinary humans can (or should) do. Although the replica cow did not have moving parts, it was an imitation of life convincing enough to attract a real bull to mount it when it was wheeled out to the pasture. Daedalus’s realistic, life-size sex toy presents a remarkable form of ancient *techne-pornography*. The witch-queen Pasiphae’s lust for a bull is nothing like the fanciful liaisons, never explicitly detailed, between a mortal woman and a god in animal disguise, such as Zeus in the form of a swan impregnating Leda. The cow made by Daedalus was not an automaton or machine; rather, in effect, Pasiphae became the internal “living” component of a “sexbot” heifer fabricated with the intention of enabling her to copulate

with a live bull. The details in the myth of Pasiphae's zoophilia compel one to visualize the grotesque sex act made possible by Daedalus's cunning biomimetic design.²²

The story of how Daedalus enabled Pasiphae's bestiality was very popular in Greek and Roman times, perpetuated by many ancient authors.²³ Illustrations of the Pasiphae tale abound in frescoes, mosaics, sarcophagi, and other artworks. A relief on a clay cup made in Tarsus, Anatolia, in the first century BC, for example, depicts Daedalus showing Pasiphae the lifelike heifer. Daedalus presents the cow to Pasiphae in several colorful frescoes discovered in Pompeii and Herculaneum (in one of the paintings, Daedalus's bow-drill is shown). A similar scene appears in the mosaic floor of a Roman aristocrat's villa in Zeugma, Asia Minor. The story struck chords in the Middle Ages and later times too. Medieval miniatures tend to focus on the romance shared by Pasiphae and a gentle, love-struck bull, while modern paintings and etchings often show a lascivious Pasiphae eagerly entering the wooden cow.²⁴

As Palaephatus pointed out, what happened next in the myth would have been impossible because different species cannot reproduce offspring, and, moreover, no woman could tolerate sex with a bull or carry a fetus with hooves and horns. In the myth, Pasiphae gives birth to a monster: a baby boy with the head of a bull. The question of how Pasiphae could breastfeed the infant Minotaur arose in antiquity, with some suggesting that a real cow would have to have been his wet nurse. A fine red-figure painting on a cup of the fourth century BC found in an Etruscan tomb shows a frowning Pasiphae with the baby Minotaur on her lap (fig. 4.3). Her hand gestures suggest surprise or hesitation. The earliest artworks depicting the Minotaur antedate the written myth by centuries, going back to the eighth century BC, and by the sixth century BC the Minotaur had become a favorite subject for vase painters.²⁵

The Minotaur's birth was a nasty shock for King Minos. Another branch of the myth tells how the Minotaur—who grows up to be a cannibalistic ogre—is imprisoned in the Cretan Labyrinth, a bewildering covered maze designed by Daedalus, of course. Every year a group of young men and maidens from Athens must be sacrificed to the Minotaur, until the Athenian hero Theseus manages to slay the man-bull monster in his maze. Theseus escapes from the Labyrinth with the help of Ariadne, daughter of Minos: Ariadne has given Theseus a ball of wool, telling him



FIG. 4.2. Daedalus, with saw, making a realistic cow for Pasiphae, Roman relief, first to fifth century AD, Palazzo Spada. Photo by Alinari.



FIG. 4.3. Pasiphae and the baby Minotaur, red-figure kylix found at Vulci, fourth century BC, Cabinet des Médailles, Paris. Photo by Carole Raddato, 2015.

to tie one end to the entrance of the Labyrinth and unroll the yarn, so that after killing the Minotaur he can follow the thread, retracing his steps. It is none other than Daedalus who has given Ariadne the ball of wool and the instructions for threading his own Labyrinth.²⁶

Deeply offended by the inventor's crimes, Minos imprisons Daedalus and his young son, Icarus, in the Labyrinth. What escape plan would Daedalus devise?



Gazing at the horizon where sky met sea, Daedalus dreams up an audacious scheme to free himself and his son from Minos's prison. What if they could fly away like birds? The myth of Daedalus and Icarus soaring aloft on wings made from real feathers and wax is another case of imaginary biomimetic technology to enhance human powers. Narrated by so many storytellers over the centuries, memorialized by countless artists, the tale is one of the most beloved myths of classical antiquity.²⁷

Daedalus collects bird feathers and layers them according to size like real pinions, using beeswax (or glue, one of his inventions). He makes two pairs of wings to strap onto himself and his son. Daedalus instructs Icarus to be careful not to fly too high, lest the sun's heat melt the wax or glue, and to avoid dipping too low over the sea, because the moisture might cause the wings to fall apart. But young Icarus, enraptured by the experience of flight, soars too high. As the sun melts the wax, the feathers flutter away and the youth plummets into the sea.²⁸

In sorrow, Daedalus flew on, stopping at various Mediterranean islands, and finally making his way to Camicus, Sicily, ruled by King Cocalus. Some said Daedalus dedicated his wings to Apollo in a temple at Cumae, whose walls were decorated with the inventor's life story painted by Daedalus himself. Some skeptical writers, such as Palaephatus (12 *Daedalus*) and Pausanias (9.11.4), rejected the myth of his flight, however. They suggested that the story arose because Daedalus was in reality the first inventor of sails, which archaic people had once likened to wings that allowed ships to "fly" over the waves. In this story, Icarus drowned at sea and was buried by Heracles on the island of Icaria.²⁹ But the main thread of the myth continues with King Cocalus welcoming Daedalus and offering him protection from Minos. Everyone knows that



FIG. 4.4. Daedalus making wings for Icarus at his workbench, ancient Roman relief, Museo di Villa Albani, Rome, Alinari / Art Resource, NY.



FIG. 4.5. Icarus with wings, small bronze figure, about 430 BC, inv. 1867,0508.746. © The Trustees of the British Museum.



FIG. 4.6. Icarus flying over fisherman in boat; King Minos in the city of Knossos. Roman lamp, first century AD, inv. 1856,1226.470. © The Trustees of the British Museum.

the king of Crete is pursuing his escaped captive, looking for Daedalus in all the major cities across the Mediterranean.

The earliest references to the escape from Crete by human-powered flight are not written but artistic. The oldest image, discovered in 1988, is fascinating for two reasons. It is Etruscan, not Greek, evidence that the Daedalus flight legend had already reached Italy by word of mouth by the seventh century BC, long before the myth was first written down. On an Etruscan *bucchero* jug made in about 630 BC a winged man is labeled

“Taitale,” Daedalus’s name in Etruscan. On the other side is Medea with her cauldron, inscribed with her Etruscan name “Metaia.” This unique pairing of Daedalus and Medea is unparalleled in ancient art; it suggests that the Etruscans linked these two mythical figures because of their wondrous *biotechne*.

Many Etruscan carved gems depict Daedalus/Taitale at work. Another unusual Etruscan artifact, a beautiful golden *bulla* (locket, 475 BC) is decorated with images of Daedalus and Icarus on each side, labeled with their Etruscan names, Taitale and Vikare. They are wearing their wings and carrying tools (saw, adze, axe, and square), details that emphasize craftsmanship and technology.



FIG. 4.7. Daedalus hovering over the body of Icarus fallen on the shore, an eighteenth-century drawing of an ancient mural, Pompeii, first century AD. Ann Ronan Picture Library, London, HIP / Art Resource, NY.

The earliest Greek representation of Daedalus is on a vase of about 570 BC: he is wearing wings and carrying an axe and a bucket. The earliest confirmed image of Icarus is on a fragment of black-figure Athenian pottery of about 560 BC showing the lower half of a man with winged footgear, clearly labeled “Ikaros” (wings on his feet appear in other ancient artworks too). A painted red-figure fragment of about 420 BC shows Daedalus fastening the wings on Icarus, and on a fifth-century BC vase, Icarus plunges into the sea. On a fragment of a fine red-figure vase (390 BC, fig. 4.8) we see a devastated Daedalus carrying his dead son.³⁰



FIG. 4.8. Daedalus carrying his dead son, Icarus, Apulian red-figure pottery fragment of a krater, Black Fury Group, about 390 BC, inv. 2007,5004.1. © The Trustees of the British Museum.

More than a hundred ancient images of Icarus and Daedalus are known. Many of them show Daedalus at work surrounded by his tools, making the wings; others show him attaching the wings to his son, Icarus, and Icarus falling from the sky. In Roman times, the story continued as a favorite poignant subject for artists, appearing on carved gems, molded clay lamps, bronze figurines, reliefs, and frescoes. A large group of Roman cameos and glass gems illustrate the story, while several murals in Pompeii capture the moment of Icarus's death, with a horrified Daedalus hovering above his son's broken body on the seashore. The myth's merging of optimism and despair made it a compelling allegorical *topos* in the Middle Ages too. Although the story may seem a cliché today, one can appreciate how it may have been read: high hopes for man-made technology to artificially enhance human capabilities are cruelly dashed by complacency, hubris, and unanticipated consequences.³¹



Yet the dream that men could somehow fly like birds far above the earth did not die with Icarus. After all, in the myth Daedalus and Icarus did become airborne and flew successfully, and—despite the high cost of his innovation—Daedalus himself survived the flight to Sicily. Humans hitching rides on birds and insects are featured in Aristophanes's plays, in Aesop's fables, and in ancient Persian traditions. A unique ancient “science fiction” about human flight was written by Lucian of Samosata (b. ca. AD 125). In *Icaromenippus* (or “The Sky Man”), Lucian’s popular tale, the philosopher Menippus imitates Daedalus and makes himself a pair of wings to fly to the moon. On his voyage, he observes that earthlings resemble tiny ants scurrying about meaninglessly.³²

One of the most memorable flying “machine” designs in antiquity appears in the *Alexander Romance* legends, in which Alexander is consumed by the desire to explore two great unknowns, the heavens and the oceans. He harnesses the power of birds to fly and dives like a fish in the deep sea, thanks to two inventions. One device is decidedly magical but the other involves technological ingenuity.

Alexander’s diving bell required creative technology. His discovery of a huge crab and giant pearls on a beach fuels Alexander’s wish to explore the mysterious depths of the ocean and see its denizens for himself. In

classical Greece, primitive diving bells, described by Pseudo-Aristotle (*Problems* 32.96ob32), already allowed deep-sea sponge divers to remain under water longer by breathing air trapped in an upside-down cauldron let down into the sea. In the *Romance* legend, Alexander explains how he made a diving bell by encasing a large, man-sized glass jar inside an iron cage, sealed by a lead lid. Alexander climbs inside. Breathing the air trapped in the glass vessel, he is lowered into the ocean by a chain from his companions' ship. At a depth ranging between 454 and 1,400 feet depending on the version, Alexander observes many fabulous deep-sea creatures.

But he almost does not survive the expedition. Suddenly a gigantic fish seizes the diving bell, dragging it and the ship along more than a mile. The great fish crushes the iron bars in its jaws, and finally spits the glass vessel with Alexander still inside onto the beach. Gasping on the shore, Alexander tells himself to give up "attempting the impossible!"³³ As with the fall of Icarus, the "moral" often attached to the *Romance* traditions cautions against the hubris of overreaching human limits. But, in fact, the thrilling audacity of Alexander's undersea and space adventures—to go where no human had gone before—seems more likely to obscure that message. Despite the risks, like Daedalus the bold explorer did live to tell the tale.

Pictures of Alexander "piloting" his diving bell and his flying machine appear in literally hundreds of illustrations in manuscripts, mosaics, sculptures, and tapestries from AD 1000 to 1600. Unlike the technological construction of his iron and glass diving bell, the flying machine is powered by two huge unidentified white birds, vultures, or griffins, goaded ever upward by horse livers dangled on spears above them. The fantasy plays on the folk motif of the donkey lured forward by a carrot on a stick.³⁴ Alexander flies higher and higher and the air becomes colder and colder, until he peers down at the earth, which now resembles a small globe in the blue ocean's bowl, seemingly insignificant compared to the vastness of the heavens. The scene is remarkably prescient, anticipating the humbled reactions of modern astronauts and viewers of the first pictures of the small blue planet Earth seen from space. This story elaborates on Alexander's wishes to surpass the limits of human capacities, seeking knowledge "beyond the world." Satisfied with his bird's-eye perspective from the stratosphere, Alexander returns to earth.

Daedalus too returned to earth. As we saw, he landed in Sicily and found refuge from King Minos in the court of King Cocalus of Camicus. We pick up the thread of this peripatetic inventor's exploits in the next chapter.



HUMAN-POWERED FLIGHT

The experiments by Daedalus and Alexander reflect an age-old fascination with technology's potentials, envisioned in early myth, legend, and folklore, to exceed human boundaries and create artificial human enhancements. The wish to imitate birds' exhilarating freedom persists, leading many others to try to achieve Daedalus's feat. In the Greek myth, Daedalus's "impossible" human-powered flight involved simply imitating birds, by flapping man-made feathered wings attached to one's back and arms. Large kites in the shape of birds' wings and other wing-beating flying devices were tested in China as early as the first century AD.³⁵ A Chinese text of the fourth century AD relates that a people of the Far West invented a flying machine driven by wind and had to make an emergency landing in Shang dynasty territory (Yellow River valley, ca. 1600–1046 BC). The Shang ruler destroyed the machines so that they could not be copied, but the stranded pilots rebuilt them and flew back home.³⁶

In about 1500, Leonardo da Vinci, who was familiar with Greek myths, not only made designs for a diving bell and suit, but also sketched several plans for human-powered ornithopters (mechanical wing-flapping devices modeled on bird and bat wings). There is no evidence

of physical prototypes or test flights for Leonardo's plans. But models based on his drawings have been made, most recently in 2006 by the Victoria and Albert Museum in London for an exhibit on early flight.

The glorious notion of flying by human power alone has inspired numerous intrepid modern inventors to find ways to overcome the problems of aerodynamics and power-to-weight ratio. One clever suggestion was to find a way to use foot-pedaling energy. Leg-powered flight was long considered to be impossible. Aeronautical engineers believed that no aircraft could be light enough to fly on such a limited source of power and yet be robust enough to carry a pilot—who of course would have to possess extraordinary strength and endurance. One of the first attempts was a "cycleplane" built in 1923, but it achieved only twenty-foot hops. In 1977, advances in strong, lightweight materials resulted in a human-powered plane flown by a cyclist-hang-glider pilot, who reached the modest altitude of ten feet and flew just over a mile.

It's diverting to speculate on some potential practical options that existed in antiquity for the mythic Daedalus, such as kites or glider sail-wings. Chinese

chronicles record that a prisoner named Yuan Huangtou unwillingly soared about one and a half miles with an owl-shaped kite in about AD 559, a primitive approximation of uncontrolled “hang gliding” (chapter 9).³⁷ Notably, in some ancient Greek traditions Daedalus was credited with the invention of sails for ships. Coarse linen with high tensile strength was used for sailcloth in Minoan Crete, known for its fine spinners and weavers. Linen sailcloth could be waxed for waterproofing. The natural materials and technical skills to make a simple glider were available in antiquity. A simple, experimental glider design could have been constructed by stretching and gluing waxed sailcloth over a lightweight wicker framework of giant reeds (*Arundo donax*), similar to the working gliders made by aeronautics pioneer Sir George Cayley (1773–1857), who tested his ideas with small models before building larger ones.

In myth, Daedalus was associated with weavers’ and spinners’ balls of thread. In antiquity the membraned wings of bats captured attention, and spiders were admired for floating on fine silk gossamer and weaving strong silken webs. Venturing for a moment into an ancient realm of science fiction to imagine an alternative myth for Daedalus, one might picture the inventor weaving tensile spiderwebs to

make a lightweight sail-wing apparatus, a kind of ancient glider.

Early modern versions of modern hang gliders were hindered by low lift-to-drag ratios, but now, thanks to aluminum alloy and composite frames covered with ultralight laminated polyester films, hang-glider pilots can soar for hours on thermal updrafts at altitudes of thousands of feet, simply by shifting their body weight, with little exertion, imitating the dynamic soaring ability of albatrosses and shearwaters. With a modern hang glider and the help of the winds, a Daedalus could island-hop from Crete to Sicily.

In 1988, inspired to replicate Daedalus’s flight pattern in the Aegean, the Greek Olympic cycling champion Kanellos Kanellopoulos skimmed over the Aegean Sea from the island of Crete to the island of Santorini in an ultralight craft, *Daedalus 88*, propelled by pedals. His record-setting flight of 72 miles, at an altitude of 15–30 feet, took about 4 hours of intense pedaling. The experiment was sponsored by the MIT Department of Aeronautics and Astronautics. In 2012, the Icarus Cup was established by the Royal Aeronautical Society in England, to promote the sport of human-powered flight. How amazed Daedalus would be, if only he could witness the continuing legacies of his epic flight to freedom.³⁸

