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The emergence of the Automaton Artilect – emergence of the disembodied Artificer Intelligence

BMARPAux1 - Auxiliary Paper 1: The Artilect

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Introduction

One form of intelligence nowhere adequately addressed in my view is that of the artificer. Here we have the potential for the artifice of human hands to itself be designed, and itself design, to have hands to artifice i.e. for 'computers as robots' to have its own manual dexterity and thus their own hand intellect. I call this the **arti**ficer intel**lect** or 'artilect'. It is to this form of intellect and its emergent qualities we now turn.

Disclaimer

Please note this document is auxiliary to the Bush Mechanic Action Research Project (BMARPAux1). It seeks to demonstrate the various attributes and historical manifestations of the largely ignored intelligent artificer created by humans, so as to better emphasise the need to consider humans as artificers. To do this I draw from several experts in the field and in effect largely directly reproduce sections from their works. In every instance I source the work. Sometimes I paraphrase their work, so that unlike the body of the report and other auxiliary documents this document is largely sourced from other authors.

Types of Intelligence

As you can see from the following all of the current methods of determining intelligence remain essentially cognitive. None of them relate directly to 'making or shaping useful stuff '. The categories/types essentially relate to thinking, speaking, moving, feeling, linking, 'musicing', largely without even 'beyonding' or 'future sense'. Respectively the types of intelligence indicated are: logical mathematical, linguistic, kinaesthetic, emotional, inter and intra personal, musical, spatial, spiritual and successful. Primarily the first three, even the fist two, are the stuff of conventional intelligence tests. These 11 types of intelligence are set out below.

11 Types of Intelligence

Howard Gardner (1983) originally came up with:

1. Logical Mathematical
2. Linguistic
3. Spatial
4. Musical
5. Bodily/kinaesthetic – ability to move ones body
6. Interpersonal (see No. 9)
7. Intrapersonal (see No. 8)

He later came up with an eighth one:

8. Naturalist – classificatory of natural systems (see No. 7)

Daniel Goleman identified:

9. Emotional intelligence (see No. 6)

Robert Sternberg added – and this one is also linked to Artificer Intelligence:

10. Successful intelligence – more in the sense of efficacy
    Clearly these intelligences esp. the ones noted above overlap, and may be conflated somewhat. NB: Conventional IQ really only includes the first two of Gardner's Logical Mathematical and Linguistic and perhaps spatial to some degree. Artificer intelligence or Artilect includes to a point 5 and 10 however neither adequately acknowledge the concept of artificer as building useful prototypes of socially useful artefacts.

Paul Wildman (2006) identified:

11. **Artificer Intelligence** – active practical wisdom - ability to conceive, design, implement, manipulate and fabricate artefacts useful for a improvement in the human condition - in short hand knowledge that can act ahead wisely
    [It is indeed nothing short of incredible, for me, that *none* of the first 10 forms of intelligence directly include 'hand knowledge']

Proposing an additional type of intelligence - Artilect

This article proposes an eleventh type of intelligence an artificer learning/phronesis type of intelligence which is about 'making or shaping good stuff', specifically that intelligence that enables a person to shape the actual embodiment of material, processes or structures that contribute to the betterment of individual and collective life - active practical wisdom - ability to conceive, design, implement, manipulate and fabricate artefacts useful for a improvement in the human condition - in short hand knowledge that can act ahead wisely.

In short this intelligence directly and practically responds to the question '(build or do something to demonstrate) how then should we live?' – **Artificer Intelligence**.

Ancient manifestations of the Artilect – Automaton's

Some would argue that the struggle of the artilect is the outworking of the divine imperative given in Genesis in relation to the creation of humanity to 'subdue the world' and 'go out and multiply'

Extract from http://www.stanford.edu/group/SHR/4-2/text/mazlish.html
In this account, Müller seems as much magician as mechanician. The connection is not accidental, according to Francis Yates and others, who posit a 'Hermetic Tradition' in Renaissance science. Yates's argument, for example, is that 'the Renaissance magus was the immediate ancestor of the seventeenth-century scientist.' In turn, the Renaissance magus 'had his roots in the Hermetic core of Renaissance Neo-Platonism.' [1]

[1] Francis A. Yates, 'The Hermetic Tradition in Renaissance Science,' *Art, Science, and History in the Renaissance*, ed. Charles S. Singleton (Baltimore: The Johns Hopkins UP, 1967) 258, 255, 326. Folk-lore and Fable: Aesop, Grimm, Andersen, The Harvard Classics, ed. Charles W. Eliot (New York: P.F. Collier, 1909) 325 also directly relates. See also Radu Florescu, *In Search of Frankenstein* (Boston: New York Graphics Society, 1929) 233. This is a marvellous work, well printed and illustrated, and, at the time I bought it, a wonderful buy. Compare the article by Michael Uhl, 'Living Dolls,' Geo (July 1985), and its quotation of one observer who delicately noted that Vaucanson's duck duplicated the process of digestion in full view of the spectators, 'ending the digestion process as naturally as it

It was especially Marsilio Ficino, along with Pico della Mirandola, who revived and carried forward the Hermetic tradition into the Renaissance. Ficino translated the collection of treatises that supposedly were written by Hermes Trismegistus, whom he believed to have been a real Egyptian priest and who gave an account, like Moses, of man and the cosmos. **In the Hermetic story of creation, as in Christianity, however, man is given permission by the Father not only to dominate over the animals, but also to share in these demiurgic powers, and also to create and animate artificial beings, as we would call them, or, in our terms, machines with Artificial Intelligence**. Thus, in the Hermetic Asclepius, as Yates informs us, 'The Egyptian priests...are presented as knowing how to capture the effluxes of the stars and through this magical knowledge to animate the statues of their gods. Here Artificer energy is conceptualised as power over rather than power with.

Historically we can see the emergence of the **Artilect** through ancient automata. http://www.stanford.edu/group/SHR/4-2/text/mazlish.html Some examples automata in a selected group of examples: the 'Nightingale' of Hans Christian Andersen's Fairy Tales, the creature in Frankenstein by Mary Shelley, the 'Tiktok' of the Oz stories, the R.U.R. of Karel Capek, and assorted robots of Isaac Asimov. Even more spectacular were the automata of Pierre Jaquet-Droz, a Swiss, who 'in 1774...created a life-sized and lifelike figure of a boy seated at a desk, capable of writing up to forty letters.' (He still functions at the History Museum in Neuchâtel.) Droz created another figure called the 'Artist', in the shape of a boy that could draw up to four different sketches, improving on the average work of his human counterpart.

Current manifestations of the Artilect - Inspector Gadget

The Industrial Age and to today sees us obsessed with technological gadgets of all descriptions so much so that we wonder how we could survive without them, a little like Inspector Gadget (a sort of artificer prototype (humanoid computer) of artifice prototypes (gadgets) in the Children's cartoon series now a movie the inspector (as to?) uses all types of gadgets to go about his crime fighting work. In today's gadget age we 'artifice ourselves' with PDA's, mobile phones, wrist watches, pace makers, smart credit cards and so forth. We have become our own inspector gadgets.

Future manifestations of the Artilect - The Singularity

Nowadays with the advent of emergent sentient technology Artificial Intelligence (AI1) is blending with Artificer Intelligence (AI2). Further humanity has essentially failed to harness AI1 to better its lot especially in the arenas of (1) Governance, (2) Poverty eradication, (3) Environmental sustainability, (4) **Kids & Adults Learning** innovations and (5) Positive Peace. One common process across all these arenas is, this book argues, the Artificer or Bush Mechanic. With the dominance of hard technology over social technology however, socio-technical systems improvements in the above 5 arenas have fallen far far behind hard technology. So much so that now it

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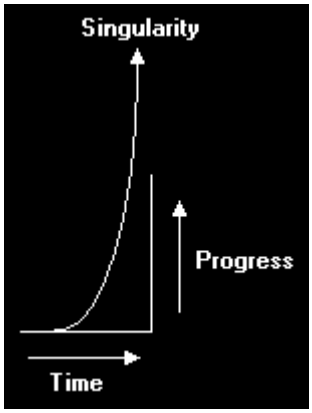
began'(86). Thus, long before Pavlov, the idea of a viewable pouch in the stomach was employed, not in a dog, but in an automaton. In the seventeenth century, Sir Kenelm Digby, member of the Royal Society, had already declared that birds were machines, whose motions when feeding their young or building their nests were no different from the striking of the clock or the ringing of an alarm. See Keith Thomas, *Man and the Natural World* (New York: Pantheon, 1983) 35.

is claimed that hard technology is evolving at over 2000000 times the rate of biological evolution and with social evolution going backwards this century then we are in a most serious predicament.

Here we see the link to the singularity when collective human intelligence on earth will be exceeded by computer intelligence for the first time. This is anticipated around mid this century. http://www.accelerationwatch.com/

Singularity: The rise of hyper intelligent life, created through the improvement of human tools by the acceleration of technological progress reaching the point where human intelligence is at first equalised then exceed by computer based 'artificial intelligence'. http://www.singularity.org/ . Such a position of course is a moving target as the process is interactive in that human tools also have the potential to improve the intelligence of their makers as well as their own intelligence.



Technologies Which Will Take Us to Singularity:
1 Computer software endowed with heuristic algorithms
2 Artificial entities generated by evolution within computer systems
3 Integration of the human nervous system and computer hardware
4 Blending of humans and computers with user interfaces
5 Dynamically organizing computer networks
6 Ongoing failure of improvements in human governance soft systems

In fact the split between thinking and doing will probably insist that 'to get things done' and 'to get humans out of harms way' AI in the sense of Artificial Intelligence

Resources on multiple intelligences @ 10-2006

Howard Gardner. (1983). *Frames of Mind: The Theory of Multiple Intelligences*. Basic Books.

Howard, Gardner. (2003). *Multiple Intelligences after Twenty Years.* Invited Address, American Educational Research Association, April.

http://www.infed.org/thinkers/gardner.htm

Gardner, H. (1983). *Frames of Mind: The Theory of Multiple Intelligences*. Basic Books.

Multiple Intelligences: A Theory for Everyone
http://www.education-world.com/a_curr/curr054.shtml

Howard Gardner's theory of multiple intelligences makes people think about ‘IQ,’ about being ‘smart.’ The theory is changing the way some teachers teach.

The man-machine and artificial intelligence

Bruce Mazlish 1

Drawn from: *SEHR, volume 4, issue 2: Constructions of the Mind*
Updated 10 July 1995 http://www.stanford.edu/group/SHR/4-2/text/mazlish.html

For thousands of years humans have wrestled with the question of their ‘human’ nature. In particular, they have attempted to define themselves in relation to the animal kingdom. Yearning either to take on some of the superior attributes of other animals or to rise above their own animal nature by becoming angelic, humans have mostly sought to define themselves as a special sort of creation.

Humans have also created machines; and their new creations, in turn, have raised the question of whether animals are merely a variant of the machine and whether the machine, as a kind of monster, can turn against its creator and either ‘take over’ or make humans over into its own image.

These concerns about man's animal and mechanical nature came forcefully together in the West in the seventeenth century and did so in terms of a debate over what was called the animal-machine, today this would be called our ‘cybernetic’ nature. Were animals mere machines, and were humans the same-that is, man-machines?

René Descartes's answer, for example, was that animals were simply machines; and human beings, if one were to set aside their possession of an immaterial soul, might also simply be considered as machines. His famous dualism, however, saved human uniqueness. Michel de Montaigne and his followers took an opposite tack, often asserting the superiority of beasts over humans, vaunting the naturalness of the former. By the eighteenth century, Julien Offray de Mettrie sought to end the debate by declaring that man was a machine, no different in this respect from any other mechanical being. Needless to say, the debate has continued to rage.

In the history of mechanical contrivances, it is difficult to know how many of the automata of antiquity were constructed only in legend or by actual scientific artifice. Icarus's wings melt in the light of historical inquiry, as they were reputed to do in the myth; but was the flying automaton, attributed to a Chinese scientist of c. 380 BC actually in the air for three days, as related? (The same story is told of Archytas of Tarentum.)1 The mix of fact and fiction is a subject of critical importance for the history of science and technology; for our purposes, the aspirations of semi-mythical inventors can be as revealing as their actual embodiment in levers and gears.

Chinese and Greek traditions are especially rich on the subject of automata. Indian and, somewhat later, Arabic sources are also copious. Western-cantered and limited as this article is, I am compelled to note the pre-eminence of Chinese science and technology in this area. Joseph Needham has made this fact evident in his monumental work, Science and Civilization in China.

The wealth of mechanical toys cited in ancient China is awesome. In addition to the flying machine mentioned earlier, mechanized doves and angels, fish, and dragons abounded; automated cup-bearers and wine-pourers were prominent; and hydraulically-moved boats, carrying figures of singing girls, animals, and men in motion are said to have amused the emperors. Of particular interest are the chariots that moved of themselves-auto-mobiles-attributed by legend to the scientist Mo Ti in the fourth century BC. Were they actually wheelbarrows, or 'pedicarts'? A mechanical man of jade is reported, as well as all kinds of wooden dolls, gold Buddhist statues, and puppet orchestras.

'What is man?' asked such automata, by their actions. 'Man is the mechanician' is the most obvious answer. Are humans also machines? Needham cites a long passage, which I repeat here, that vividly gives us the flavour of automata development in China and raises the questions of humans' dual nature. The passage, from the Lieh Tzu, whose probable date is the third century BC, tells of how

King Mu of Chou made a tour of inspection in the west...and on his return journey, before reaching China, a certain artificer, Yen Shih by name, was presented to him. The king received him and asked him what he could do. He replied that he would do anything which the king commanded, but that he had a piece of work already finished which he would like to show him. `Bring it with you tomorrow,' said the king, `and we will look at it together.' So next day Yen Shih appeared again and was admitted into the presence. `Who is that man accompanying you?' asked the king. `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. It went through any number of movements that fancy might happen to dictate.

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 kidney and the legs lost their power of locomotion. The king was delighted. Drawing a deep breath, he exclaimed, `Can it be that human skill is on a par with that of the great Author of Nature?'

‘Anyone would have taken it for a live human being’-here we have one of the key phrases. The robot makes advances to the ladies and incurs the King's wrath, presenting a sexual threat which is so prevalent, as we shall see, in fears about automata. In the sentence ‘Can it be that human skill is on a par with that of the great Author of Nature?’ is sounded what in the West we know of as the Promethean theme. 2

The Greeks, too, were absorbed with automata of one kind or another. The Delphic oracles spoke through a wind-operated ‘voice,’ and the god Hephaestus is said to have forged a sort of robot of bronze, named ‘Talos,’ to guard Crete. Indeed, statues and effigies were themselves god-like: that is, filled with the voices of the gods. We catch this sense of the statue as divine in the writing of Callistratus, in the fourth century AD, about an ivory and gold statue of the god Asclepius: ‘Shall we admit that the divine spirit descends into human bodies, there to be even defiled by passions, and nevertheless not believe it in a case where there is no attendant engendering of evil? ...for see how an image, after Art has portrayed in it a god, even passes over into the god himself! Matter though it is, it gives forth divine intelligence.’ 3

A true history of automata would give all the details, and would cover the ground systematically.4 I wish merely to highlight the topic, and to pick it up again in more modern times. Note Needham's concluding comment that when the Chinese and European traditions of mechanical toys ‘came together in the middle of the thirteenth century, the European tradition did not show up to much advantage. The triumphs of the European `Gadget Age' were yet to come.’5

In the thirteenth century in Europe, for example, we find reports of exemplary mechanical doves and angels made by Villard de Honnecourt. In the fifteenth century, the mathematician and astronomer Johannes Müller constructed an eagle and a fly that astounded his contemporaries. The twentieth-century historian of science Pierre Duhem has proposed a tentative explanation: ‘The fly, for instance, would beat its wings by means of springs concealed within it, and make the tour of a dinner-table suspended from a hair invisible to the guests, finally approaching the hand of Regiomontanus [Müller] because of a magnet secretly held by him.’6

In this account, Müller seems as much magician as mechanician. The connection is not accidental, according to Francis Yates and others, who posit a ‘Hermetic Tradition’ in Renaissance science. Yates's argument, for example, is that ‘the Renaissance magus was the immediate ancestor of the seventeenth-century scientist.’ In turn, the Renaissance magus ‘had his roots in the Hermetic core of Renaissance Neo-Platonism.’7

It was especially Marsilio Ficino, along with Pico della Mirandola, who revived and carried forward the Hermetic tradition into the Renaissance. Ficino translated the collection of treatises that supposedly were written by Hermes Trismegistus, whom he believed to have been a real Egyptian priest and who gave an account, like Moses, of man and the cosmos. In the Hermetic story of creation, however, man is given permission by the Father not only to dominate over the animals, but also to share in the demiurgic powers: that is, to create and animate artificial beings, as we would call them, or, in my terms, machines. Thus, in the Hermetic Asclepius, as Yates informs

us, ‘The Egyptian priests...are presented as knowing how to capture the effluxes of the stars and through this magical knowledge to animate the statues of their gods.’8

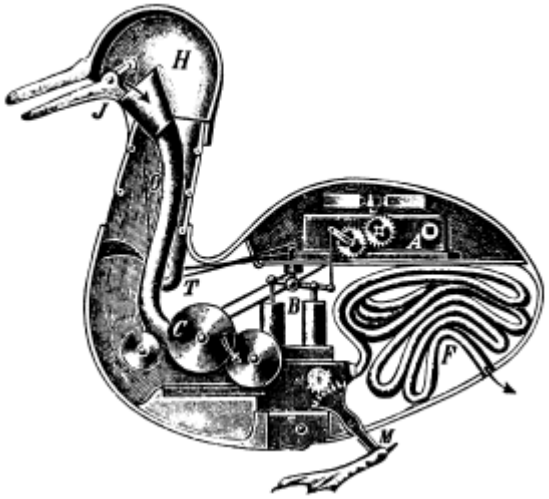
Alchemy was the Hermetic science par excellence. Mere matter could be transformed, for example, into gold, but life also could be distilled from the alchemist's retorts. The other means of creating life out of inanimate matter was through cabalistic conjurations. Small wonder that an air of mystery and magic hung over the Renaissance magus, who rapidly also gained the taint of charlatanism. John Dee, the Elizabethan scientist, is a prime example of the confusion of magic, ‘chemistry,’ and mechanics. Called the ‘great conjurer’ for his magic summoning of angels, he was also suspect for his mechanical powers. In vain he protested: ‘And for...marvellous Actes and Feates, Naturally, Mathematically, and Mechanically wrought and contrived, ought any honest Student and Modest Christian Philosopher, be counted and called a Conjurer?’9

In the Hermetic tradition of the Renaissance, the ancient fascination with automata took on new life. Magic and mechanics were intertwined, and an air of fear and wonder hovered over the statues and angels conjured out of the earth and air: are they alive and real, or not? Are humans, indeed, mechanicians, who can breathe life into what they have created, thereby imitating their own Creator? Or are they merely machines themselves, working on mechanical principles? In the Hermetic tradition of the Renaissance, these questions are close to the surface, though enveloped in mythical and magical shapes.

A century or two later, having passed through the cleansing and brightening waters of Baconian and Cartesian thought, the automata giving rise to these questions took on, seemingly, a more secular, more reasoned form. In the eighteenth century, one of the most skilled technicians was the Frenchman Jacques de Vaucanson. He produced a duck which, we are told, ‘drank, ate, digested, cackled, and swam-the whole interior apparatus of digestion exposed, so that it could be viewed; [a] flute player who played twelve different tunes, moving his fingers, lips and tongue, depending on the music; [a] girl who played the tambourine, [and a] mandolin player that moved his head and pretended to breathe.’

Even more spectacular were the automata of Pierre Jaquet-Droz, a Swiss, who ‘in 1774...created a life-sized and lifelike figure of a boy seated at a desk, capable of writing up to forty letters.’ (He still functions at the History Museum in Neuchâtel.) Droz created another figure called the ‘Artist,’ in the shape of a boy that could draw up to four different sketches, improving on the average work of his human counterpart.10

These mechanical figures were bathed, at the time of the Enlightenment, in the pure light of reason, and discussion of them took place in unambiguous ‘scientific’ terms. We have already listened to some of the discourse, ranging from Descartes to La Mettrie. Underlying this discussion, however, as I shall try to show, ran the fears of the automata, for they posed an ‘irrational’ threat to humans, calling into question their identity, sexuality (the basis of creation?), and powers of domination.



Jaques Vaucanson, Canard digérant, from *Le monde des automates* (1928).

Automata provoked not just fears, but also the promise of creative, Promethean force. The tension between these two aspects of the automaton-at play in various examples of the genre-is most interesting. I shall try to explore the human ambivalence toward automata in a selected group of examples: the ‘Nightingale’ of Hans Christian Andersen's Fairy Tales, the creature in Frankenstein by Mary Shelley, the ‘Tiktok’ of the Oz stories, the R.U.R. of Karel Capek, and assorted robots of Isaac Asimov.

I could have chosen innumerable other examples, for tales of the automata are legion. Those I have chosen, however, are classic examples (Asimov's are currently becoming so) and illustrate different aspects of the human encounter with the mechanical ‘other.’ Andersen's tale hinges on clockwork mechanisms; Shelley's Frankenstein-perhaps the dominant Western metaphor for the fourth discontinuity, straddling both biological and mechanical fears-holds an importance which is self-evident and thus deserves extended treatment; Baum's Oz stories, which obsessively reflect a childlike curiosity about ‘life,’ are hardly as innocent as they appear; Capek's R.U.R. gives birth to the term ‘robot,’ and voices the fear of robots taking over-a fear echoed today in countless films about menacing androids; and Asimov's varied cast of robots allows us to explore many of the intellectual dimensions of the predicted coming of a robotic age.

Let us begin with Hans Christian Andersen's ‘The Nightingale,’ a famous tale from the nineteenth century. It reflects both the scientific concern with automata and the Romantic revulsion towards the mechanical Newtonian world view. Newton had imagined the universe as clockwork. The clock, with its intricate, precise, and more or less unfailing machinery, symbolized the new age of scientific method and industrial discipline. It also prompted additional speculation about the relation between the internal ‘works’ of human beings and clocks.

In Andersen's tale, we are presented with a ‘real nightingale’ and one that requires a ‘watchmaker.’11 The tale itself is a simple one. The real nightingale charms a Chinese emperor and his peasants alike. Its song brings tears to their eyes. Subsequently, an artificial nightingale appears, even handsomer than the real one because it is ornamented with precious stones. It appears to sing as well and more repeatedly, and is as well received as the original. Banished, the real bird flies away. After a year, however, the artificial nightingale begins to break down, and cannot be

fully repaired. A few years later, the emperor lays dying, and only the nightingale's song can save him. But the artificial bird has now completely wound down. Suddenly, the live nightingale appears, sings to the emperor, and he comes back to life.

In Andersen's telling, the tale has a poignancy and meaning that cannot be conveyed in a précis. Examined closely, the short story also takes on unexpected ambiguities. The compelling note is the constant comparison between human-made and 'natural' things: at the beginning, the croaking of frogs is mistaken for church bells by the courtiers, the nightingale's song for glass bells. The artificial bird and the real nightingale cannot sing well together, 'for the real Nightingale sang in its own way, and the artificial bird sang waltzes.'12 At first, the palm seems to go to the mechanical contrivance for 'three-and-thirty times over did it sing the same piece, and yet was not tired.' Praising it, the artificer explains how 'with a real nightingale one can never calculate what is coming, but in this artificial bird everything is settled.'

In fact, the artificial bird is neither untiring nor settled. It breaks down, and cannot be repaired. In contrast, the nightingale goes on living, as if for eternity. (While I do not know exactly how long a nightingale can live, I suspect not too many years; of course, new ones can be produced, but so can machines.) Thus, the qualities normally assigned to animate (living) objects and inanimate (non living) objects are reversed: it is the animate that endures. This theme is reiterated at the end, when the real nightingale, symbolizing the forces of life, banishes death: in the words of the emperor, 'I banished you from my country and empire, and yet you have charmed away the evil forces from my couch, and banished Death from my heart!'13

Through this short story, Andersen is saying that the difference between humans and automata is simple and straightforward: one represents life and the other death, cold and mechanical. It is the Romantic lament. As the nightingale tells the emperor at the end, 'I will sing of those who are happy and of those who suffer. I will sing of good and of evil that remain hidden round about you.'14

Though Andersen's answer to his question about humans and automata is seemingly an untroubled one, it is really surrounded by ambiguous thoughts and feelings. (Andersen had an unhappy youth and occupied his time in solitude by constructing puppet theaters.) His tale is not calculated to satisfy those who felt, and feel, themselves deeply puzzled and disturbed over the mysteries of life and mechanism.

The artificial nightingale is a clockwork figure. Mary Shelley's Frankenstein draws on other sources: it reaches back to the Hermetic tradition, to which it adds the threatening aspect of the legendary golem. Badly written, stilted, a pastiche of styles and inspirations, the book nevertheless exercises an uncanny power over us. It is an alchemist's brew of ideas, whose very formlessness allows us to instill in it all the shapes and forms of our own imagination. Frankenstein's monster looms over our most primordial fears and desires, hulking above our ambivalent feelings toward animals and machines, symbolizing the way in which they take on a 'life' of their own.

Mary Shelley had no formal education. Nevertheless, being the daughter of Mary Wollstonecraft and William Godwin, she moved into a circle of advanced thought. Influenced by the enlightenment of her time, she also breathed the air of mysticism

and romanticism that emanated from the Gothic novels of Walpole and Rutledge, and the poetry of Samuel Taylor Coleridge. Her peculiar genius was to connect the ancient myths with early nineteenth-century science.

The Hermetic tradition seemingly had blessed humans' participation in the demiurge, and looked benignly on their efforts to give life to inanimate statues. In Frankenstein, a dark shadow creeps over these efforts: Cornelius Agrippa, Paracelsus, and Albertus Magnus, ‘canonical’ figures in the Hermetic tradition, are all mentioned as the hero's inspirations, but they are shown as Mephistopheles-like figures, leading him to perdition. It is a golem, not the statues of Hermes Trismegistus, that here becomes animated.

Golems may have originated as wooden or clay models of human beings that were placed in graves to act as servants of the dead.15 In Europe, they take on an especially legendary form in the sixteenth century. The golem, a shapeless mass of clay, could be given form by conjuration: in this case, Jewish cabalism. A rabbi pronounces holy words, and writes on the creature's forehead ‘Emeth,’ meaning ‘truth’ in Hebrew, thus endowing it with life. By erasing the ‘E,’ the word becomes ‘Meth,’ which means ‘death,’ and the creature disintegrates. (In another version, the rabbi writes ‘Shem’ [the name of God], but the process is the same.)

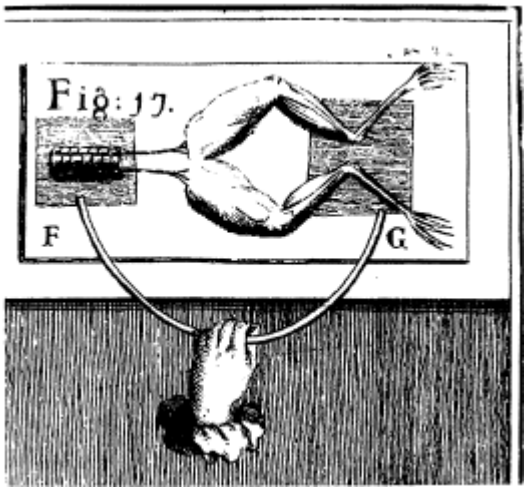
The golem is supposedly man's servant. He exists to protect his maker. But in the legends, the golem almost always also threatens its master-running out of control, falling on him, or going berserk-and must finally be destroyed. (The most famous golem is that in the service of Rabbi Loew, in early seventeenth-century Prague.)16

Mary Shelley doesn't make overt reference to the golem tales; but they, along with the Hermetic tradition, lie behind her story. Further influences crowd in. Her rationalist father, William Godwin, had written a book, Lives of the Necromancers, which, though not published until 1834 (by Mary), reflected earlier conversations between him and his daughter about Agrippa, Paracelsus, Albertus Magnus, the Rosicrucians, and other cabalistic and magus-like sources. Another current of thought-contemporary science, especially chemistry and electricity-came into play in Mary's mind through her husband, Percy Bysshe Shelley. Though a poet, Percy Bysshe Shelley was fascinated by science. Like Godwin, he had read Paracelsus (who, incidentally, was famous for having claimed that he could create ‘a little man or homunculus’). As a boy, Shelley had also become intrigued with chemistry, and his rooms at Eton are said to have resembled an alchemist's laboratory. He was also exposed, according to one scholar, ‘to androids, or mechanical toys that functioned like humans-a product of the scientific genius of Adam Walker, to whose lectures he had listened.’17

At Oxford, Shelley also experimented with electrical machines, air pumps, galvanic batteries, and other such paraphernalia. Though Lord Byron probably encouraged Mary Shelley to read Sir Humphry Davy's Elements of Chemical Philosophy (1812) at the time she began the composition of Frankenstein, it was her husband, Percy, who really served as the lightning rod, connecting the ancient alchemists and the modern genie of science in her thought. Indeed, it was Percy who urged her on with the book, helped her write it, penned the preface, and secured its publication.

Davy's Elements, which hinted at the possibility of discovering a life force-a subtle universal fluid or vital magnetism-dealt with recent researches into galvanism and electricity. Luigi Galvani's work, or what I like to call the ‘galvanic twitch’ (whose movement through nineteenth-century thought has still not been sufficiently traced), had demonstrated the identity of electrical and chemical forces-that is, their inter-convertibility. It also suggested that galvanic electricity could bridge the gap between the animate and inanimate; the frog's leg made to twitch seemed to lead to Aldini's experiment in which a shock applied to a recently hanged man produced an effect that, as he wrote, ‘surpassed our most sanguine expectations, and vitality might perhaps have been restored if many circumstances had not rendered it impossible.’18

Percy Bysshe Shelley was probably also influenced by the climate of opinion embodied in the term Natürphilosophie, though it remains something of a will-o'the-wisp in the history of science except among specialists. An important movement of thought in the early nineteenth century, it has generally been treated with scorn, as befitting a kind of mystical attitude to nature. Though it emphasized vitalism and holism against the dominant materialism and analysis of contemporary Western science (hence, the scorn), both types of philosophy sought to depict the universe as unified and falling under one connecting net of forces, and thus, laws. In any event, Natüphilosophie propagated the idea of the inter-convertibility of forces, linking the animate and inanimate through galvanism, magnetism (in the form of Mesmerism, it becomes ‘animal magnetism’), and electricity. Thus animating forces could be made to run between the poles of life and death.



The Galvanic twitch. Twitching frog's legs lead from Galvani to Aldini's experiments, thence to Mary Shelley's Frankenstein and the supposed creation of life by means of a spark infused into inanimate materials (Courtesy Burndy Library, Dibner Institute, MIT, Cambridge, MA.)

Mary Shelley's knowledge of these developments in science was a hodgepodge; she only dimly and intuitively grasped their meaning. But, like the ancient alchemists, she thought she knew enough to attempt their transmutation into the gold of art-and succeeded, creating an immortal work of fiction, Frankenstein. In 1816, on the edge of Lake Leman, Geneva, Switzerland, the shreds and tatters of true science were combined with the myths of antiquity.

We can reconstruct Frankenstein's composition. Byron and a friend, Dr. John Polidori, had joined Mary and Percy. Outside their villa a storm rages; the friends amuse and terrify themselves by telling ghost stories. Byron then proposes that each write his or her own. That night, Mary has a nightmare in which, as she tells us, ‘I saw the hideous phantasm of a man stretched out, and then, on the working of some powerful

engine, shows signs of life, and stir with an uneasy, half vital motion.' From this nightmare, Frankenstein is born.19

I have given some of the background to Mary Shelley's book because to do so illustrates vividly the range of human curiosity, embodied in scientific inquiry and legendary stories, concerning the creation of life from inanimate material. 'More, far more will I achieve,' exclaims Frankenstein, 'treading in the steps already marked, I will pioneer a new way, explore unknown powers, and unfold to the world the deepest mysteries of creation.'20 In penetrating these mysteries, the book resurrects and reclothes a number of humanity's deepest concerns about automata: for example, the servant-machine rising against its master, the fear of the machine reproducing itself (fundamentally, a sexual fear, as the example of Caliban in Shakespeare's Tempest reminds us, and as we shall see in our further account of Mary Shelley's book), and the terror, finally, of humans realizing that they are at one with the machine-monster.

Such is the fundamental attraction and meaning of Frankenstein. But little attention has been given to the actual details of the novel, which has now passed into folklore. For this reason, I will instance material that may be familiar to scholars of the book but not necessarily to the general reader.

First, the name Frankenstein is often given to the monster created, rather than to its creator; yet, in the book, Frankenstein is the name of the scientist, and his abortion has no name. Second, the monster is not a machine but a 'flesh and blood' product; even a student as informed as the distinguished historian Oscar Handlin makes the typical quick shift when he says, 'The monster, however, quickly proves himself the superior. In the confrontation, the machine gives the orders.' Third, and last, it is usually forgotten or overlooked that the monster turns to murder because his creator, horrified at his production, refuses him human love and kindness. Let us look at a few details.

In writing her Gothic novel in 1816 to 1817, Mary Shelley gave it the subtitle, 'The Modern Prometheus.' We can see why if we remember that Prometheus defied the gods and gave fire to humankind. Writing from an early nineteenth-century Romantic perspective, Mary Shelley offers Frankenstein as an example of 'how dangerous is the acquirement of knowledge.' In this case, specifically, the capability of 'bestowing animation upon lifeless matter' and in the novel we are told of how, having collected his materials from 'the dissecting room and the slaughterhouse,' Frankenstein eventually completes his loathsome task when he infuses 'a spark of being into the lifeless thing that lay at my feet.'

Then, as he tells us, 'now that I had finished, the beauty of the dream vanished, and breathless horror and disgust filled my heart.' Rushing from the room, Frankenstein goes to his bedchamber, where he has a most odd dream concerning the corpse of his dead mother (the whole book as well as this passage cries out for psychoanalytic interpretation) from which he is awakened by 'the wretch-the miserable monster whom I had created.' Aghast at the countenance of what he has created, Frankenstein escapes from the room and out into the open. Upon finally returning to his room with a friend, he is relieved to find the monster gone.

To understand the myth, we need to recite a few further details in this weird story. Frankenstein's monster eventually finds his way to a hovel attached to a cottage,

occupied by a blind father and his son and daughter. Unperceived by them, he learns the elements of social life (the fortuitous way in which this occurs may strain the demanding reader's credulity), even to the point of reading Paradise Lost. Resolved to end his unbearable solitude, the monster, convinced that his virtues of the heart will win over the cottagers, makes his presence known. The result is predictable: horrified by his appearance, they duplicate the behaviour of his creator and flee. In wrath, the monster turns against the heartless world. He kills, and his first victim-by accident-is Frankenstein's young brother.

Pursued by Frankenstein, the creature eventually confronts its creator. The monster explains his road to murder and, in a torrential address, appeals to Frankenstein:

I entreat you to hear me, before you give vent to your hatred on my devoted head. Have I not suffered enough that you seek to increase my misery? Life, although it may only be an accumulation of anguish, is dear to me, and I will defend it. Remember, thou hast made me more powerful than thyself; my height is superior to thine; my joints more supple. But I will not be tempted to set myself in opposition to thee. I am thy creature, and I will be even mild and docile to my natural lord and king, if thou wilt also perform thy part, the which thou owest me. Oh, Frankenstein, be not equitable to every other, and trample upon me alone, to whom thy justice, and even thy clemency and affection is most due. Remember, that I am thy creature; I ought to be thy Adam; but I am rather the fallen angel, whom thou drives from joy for no misdeed. Everywhere I see bliss, from which I alone am irrevocably excluded. I was benevolent and good; misery made me a fiend. Make me happy, and I shall again be virtuous.

Eventually, the monster extracts from Frankenstein a promise to create a partner for him ‘of another sex,’ with whom he will then retire into the vast wilds of South America, away from the world of men. But Frankenstein's ‘compassion’ does not last long. In his laboratory again, Frankenstein indulges in a long soliloquy:

I was now about to form another being, of whose dispositions I was alike ignorant; she might become ten thousand times more malignant than her mate; and delight, for its own sake, in murder and wretchedness. He had sworn to quit the neighbourhood of man, and hide himself in deserts; but she had not; and she, who in all probability was to become a thinking and reasoning animal, might refuse to comply with a compact made before her creation. They might even hate each other; the creature who already lived loathed his own deformity, and might he not conceive a greater abhorrence for it when it came before his eyes in the female form? She also might quit him, and he be again alone, exasperated by the fresh provocation of being deserted by one of his own species.

Even if they were to leave Europe, and inhabit the deserts of the new world, yet one of the first results of those sympathies for which the demon thirsted would be children, and a race of devils would be propagated upon the earth who might make the very existence of the species of man a condition precarious and full of terror. Had I right, for my own benefit, to inflict this curse upon everlasting generations?

With the monster observing him through the window, Frankenstein destroys the female companion on whom he had been working.

With this, the novel relentlessly winds its way to its end. In despair, the monster revenges himself by killing Frankenstein's best friend, Clerval, then Frankenstein's new bride, Elizabeth. Fleeing to the frozen north, the monster is tracked down by Frankenstein who dies, however, before he can destroy his dreadful creation. It does not matter; the monster wishes his own death and promises to place himself on a funeral pile and thus at last secure the spiritual peace for which he has yearned.

It is important to be acquainted with the myth of Frankenstein as actually written by Mary Shelley. For most of us, Frankenstein is Boris Karloff, clumping around stiff, automatic, and threatening: a machine of sorts. (My students tell me this image is hopelessly out-of-date; for them Frankenstein is Gene Wilder in Mel Brooks's film Young Frankenstein.) We shall have forgotten completely, if ever we knew, that the monster cum machine, is evil, or rather, becomes evil, only because it is spurned by humans.

Implicit in Frankenstein is the question of an essential discontinuity. If humans insist on their separateness and superiority with regard to machines (as well as other animals), viewing them as threatening new ‘species,’ rather than as a part of their own creation, will they, indeed, bring about the very state of alienation that they fear? Do differences between humans and machines-and it would be a reductio ad absurdum to declare that there are none-add up to a discontinuity? Although Frankenstein's creation is, in fact, a monster, its existence raises the same fundamental ‘mysteries’ as if it were a machine; such are the amorphous connecting powers of myth.21

Mary Shelley, of course, was writing about creation before Charles Darwin; her ‘mysteries’ are without the benefit of his great work on what he called the ‘mystery of mysteries.’ Another Darwin, however, not Charles, was summoned directly to Mary's assistance: Erasmus Darwin, Charles's grandfather. In the preface to Frankenstein (actually written by Percy) the opening lines state that ‘the event on which this fiction is founded has been supposed by Dr. Darwin, and some of the physiological writers of Germany, as not of impossible occurrence.’22 Later, in her introduction to the 1831 edition, Mary recalls how she, her husband, and Lord Byron discussed ‘the nature of the principles of life, and whether there was any probability of its ever being discovered and communicated. They talked of the experiments of Dr. [Erasmus] Darwin...who preserved a piece of vermicelli in a glass case, till by some extraordinary means it began to move with voluntary motion.’

In Frankenstein, much ambivalence pervades the scientific quest. ‘What had been the study and desire of the wisest men since the creation of the world was now within my grasp,’ we are told by Frankenstein, but it involves him in a loathsome search through ‘vaults and charnel-houses.’ When he triumphantly announces that he has become ‘capable of bestowing animation upon lifeless matter,’ he must surround it with the disclaimer ‘I am not recording the vision of a madman.’23 His demurral aside, Frankenstein not only symbolizes the ‘modern Prometheus,’ overreaching himself, but also has come to epitomize the ‘mad scientist,’ whose hubris has removed him from the circle of humanity. If humans are created in God's world, the monster is spawned in the laboratory. Man, the evil scientist, has taken God's place.

Moreover, the scientist has also taken the place of woman. She has been displaced from the acts of conception and birth. It is the man, Frankenstein, who creates

sexlessly. In the novel, sexuality is a threatening force. (In Mary's own life, sex meant death: her mother had died giving birth to her, her best friend had died in childbirth, and so forth; thus the biographical details are important to our understanding her fiction.) If the monster is allowed to breed, it will take over from mankind. In aborting the birth of a mate, as we have seen, Frankenstein reveals not only his revulsion to sexuality, but also his racist fears: a ‘race of devils’ is how he describes the potential new species.

Mary's father, William Godwin, had also envisioned the end of sexuality in his Enquiry Concerning Political Justice. As he wrote there, ‘The whole will be a people of men, and not of children [that is, men will live more or less forever]. Generation will not succeed generation.’24 Diminished sensuality would ensure that the end of generations would also mean the end of the act of generation. Thus, Godwin foresaw a timeless, unchanging utopia where creation had taken place once and for all. Indeed, it was against this illusion that Thomas Malthus wrote his essay, Population, insisting that sex-that is, procreation-was one of the necessary postulates of human existence, the other being the necessity of food. If not prevented by moral restraint, procreation leads, in turn, to the threat of overpopulation. When we deal with Charles Darwin, we shall note how reading Malthus helped spark into life Charles Darwin's great theory of evolution by natural selection, giving humans a new, scientific account of genesis.

Mary Shelley, however, echoes her father's hopes and fears. She substitutes the test-tube for the sexual act in Frankenstein. What is more, without a real father and mother, the creature thus conceived is without nurturance and development. ‘No father had watched my infant days,’ he laments to Frankenstein, ‘no mother had blessed me with smiles and caresses.’ Like a fairer creature, Minerva, from Jove's forehead, the monster has sprung full-grown (and larger than man). He is, as a result, (because of lack of development) inhuman. Made animate by his scientific creator, he is still like an automaton, ultimately lacking in the qualities that would bridge the discontinuity between him and humans.

In Frankenstein, man, in disgust and fear, rejects his own creation. In doing so, he rejects a part of himself, his ‘double’ (recognized unconsciously by readers who refer to the monster as ‘Frankenstein’), for both Frankenstein and the monster are destroyed at the book's end. Left behind them, in the shape of the gargoyles of the mad scientist and the golem-automaton run amok, is a new-old commandment: ‘thou shalt not create matter in thine own image.’

Frankenstein still gives rise to a frisson in modern man, but it has not put a stop to his mechanical ambitions. In fact, the automaton frequently has been domesticated in the form of the robot, and often given a friendly, serving face. One such figure is found in the Oz books for children. He is called Tik-tok, and first appears in Ozma of Oz (1907). In this seemingly simple book, many of the fundamental questions surrounding man, animals, and machines are dealt with disarmingly.

L. Frank Baum, the author, seems to have had a genial obsession with the idea of human identity.25 An American Andersen of sorts, he modernized the timeless. Though in such tales the threatening characters previously were monsters-the giant in ‘Jack and the Beanstalk’-here they are often humanized and humorous machines.

Harmony reigns in the land of Oz among humans, animals, and machines, and even witches are gently laughed away.

We see these elements at play in all of Baum's Oz books, but especially in Ozma of Oz, one of his most delightful excursions into our subject.26 Dedicated to all boys and girls, it starts with Dorothy Gale of Kansas on a boat, then being washed overboard and clinging to a chicken-coop, whose only other occupant is a hen named, by Dorothy, Billina. Unexpectedly, the hen can talk, and when Dorothy says, 'I thought hens could only cluck and cackle,' the hen replies, 'I've clucked and cackled all my life, and never spoken a word before this morning, that I can remember. But when you asked a question, a minute ago, it seemed the most natural thing in the world to answer you. So I spoke, and I seem to keep on speaking, just as you and other human beings do. Strange, isn't it?' Thus, at the beginning of the book, the question of the defining quality of language-humans have language, and hens generally don't-is put before us.

We are, of course, in fairyland (though first the chicken-coop must wash ashore in the land of Ev and of Oz). The point of fairyland, however, is to define 'real land' by comparison. When Dorothy urges the hen to eat the egg it has laid, because 'You don't need to have your food cooked, as I do,' the hen indignantly cries, 'Do you take me for a cannibal?' When Dorothy, pursuing the subject, says how dreadful her companion's eating habits are-'Why, eating live things, and horrid bugs, and crawly ants. You ought to be 'shamed of yourself!'-the unflappable hen responds, 'Goodness me!... Live things are much fresher and more wholesome than dead ones, and you humans eat all sorts of dead creatures.' To Dorothy's denial, Billina instances lambs, sheep-and even chickens. Dorothy's triumphant rejoinder is 'but we cook 'em.' When the hen questions whether there is any difference, the little girl answers, 'A good deal...I can't just 'splain the diff'rence, but it's there. And, anyhow, we never eat such dreadful things as bugs!' The hen's cackling reply leaves Dorothy thoughtful: 'But you eat the chickens that eat the bugs.... So you are just as bad as we chickens are.'

We seem to be in the presence of a jovial Claude Lévi-Strauss. Humans are cannibalistic animals that cook their food and feel superior to other animals. Speech, however, allows them to examine their own actions. Baum is helping children grope toward a sense of what it is to be human, and different from hens and other animals.

A creature called 'The Wheeler' serves as an intermediary between animals, such as Billina, and machines. 'It had the form of a man,' we are told,

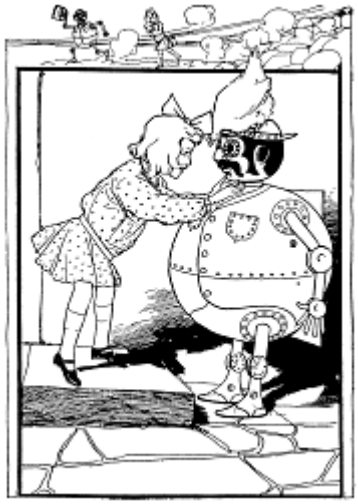
except that it walked, or rather rolled, upon all fours, and its legs were the same length as its arms, giving them the appearance of the four legs of a beast. Yet it was no beast that Dorothy had discovered, for the person was clothed most gorgeously in embroidered garments of many colors, and wore a straw hat perched jauntily upon the side of its head. But it differed from human beings in this respect, that instead of hands and feet there grew at the end of its arms and legs round wheels (pg.30).

Here, clothes seem to be the defining quality of a human, differentiating it from both a machine and an animal.

It is Tik-tok, the Machine Man, however, who occupies the central place in what comes to be a kind of comical Cartesian discourse. Dorothy finds a key that unlocks a door in a rock where she sees

the form of a man-or, at least, it seemed like a man, in the dim light. He was only about as tall as Dorothy herself, and his body was round as a ball and made out of burnished copper. Also his head and limbs were copper....`Don't be frightened,' Billina calls out. `It isn't alive' (pg.54).

Reassured, Dorothy remembers the Tin Man, and makes a comparison. ‘But he [the Tin Man] was as alive as we are, 'cause he was born a real man, and got his tin body a little at a time-first a leg and then a finger and then an ear-for the reason that he had so many accidents with his axe.’ Her conclusion is that, in contrast, the copper man ‘is not alive at all.’



Tiktok, the Machine Man. Illustration by John R. Neill, from L. Frank Baum, *Ozma of Oz* (1907). Dorothy explores, with the direct naiveté of a child's eye, the difference between humans and machines.

He is a robot. The card around his neck defines him as a ‘Clock work’ that ‘Thinks, Speaks, Acts’ (if you wind him up). He ‘Does Everything but Live’(55). Everything, that is, except eat, feel either sorrow or joy, be kind (or unkind), or sleep (these, at least, are the specific differences alluded to in the book). When, however, the Scarecrow claims that, unlike Tik-tok, he has brains, Tik-tok replies, ‘Oh, yes, I have. I am fit-ted with Smith and Tin-ker's Improved Com-bi-na-tion Steel Brains. They are what make me think’(114-115). Like the animal Billina, the machine Tik-tok has language and brains.

What, then, distinguishes ‘him’ (it?) from humans? The answer seems to reside in the specifics cited, revolving especially around emotions: that is, consciousness of a state of feeling. Also, according to Baum, Tik-tok suffers from the defect of always having to be rewound (but this is merely a technicality-after all, humans have to eat).

Another mechanical figure in the book, ‘The Giant With the Hammer,’ appears not to suffer from this latter defect (in fact, he seems to continue until turned off by a key). On the other hand, unlike Tik-tok, he has no thinking or speaking attachment. A gigantic ‘man’ made out of plates of cast iron, he stands astride the only road into the Kingdom of the Nomes, pounding the earth so that all are too scared to go past. But

his very strength-his unwearying mechanical regularity-proves his weakness, and allows him to be defeated. As the Scarecrow points out, all that the members of Dorothy's party have to do is run under the hammer when it is lifted, and pass to the other side before it falls again.

Tik-tok itself is an utterly unthreatening robot. He exists only to serve Dorothy, which he does. In the illustrations, he looks like a copper Humpty-Dumpty. Even the Giant with a Hammer is little to be feared, for he can easily be outwitted because of his mechanical qualities. Automata, in Oz, are domesticated creatures, different from hens and other animals, but no less under human-in fact, a child's-domination.

Robots, however, do not occupy only the sunny fields of Oz in our imagination. They also often take on dark, threatening shapes, such as we have seen in Frankenstein. Their more modern incarnation, in Karel Capek's R.U.R.,-which introduced the term ‘robot’ into popular usage-reflects similar fears.27

Like its Shelleyan predecessor, Capek's play R.U.R. (1921; performed in America in 1922), is a poorly written hodge-podge of mostly improbable ideas. (Perhaps this is because a crude style matches the crudeness of its creatures, or because the Gothic is necessarily crude.) In any case, Capek-a Czech-obviously wrote with one eye on the Bolshevik Revolution of 1917, though one cannot be sure of his actual attitude toward that epochal event. Between Act I, which is about the manufacture of robots, and Acts II and III, when they revolt, there is a dichotomy. Yet the play is effective and has come to symbolize much of our feelings about robots.

The play opens when Helena, a beautiful young girl, comes to visit on an island the factory of Rossum's Universal Robots, which is managed by a man, Domin. He immediately falls in love with her and, on her promise not to divulge it, tell her the true story of the invention. (The process itself is secret, preserved in only two copies.) Rossum, he says, was a ‘great physiologist,’ who ‘attempted by chemical synthesis to imitate the living matter known as protoplasm until he suddenly discovered a substance which behaved exactly like living matter.’ As Domin explains, ‘This artificial living matter of his has a raging thirst for life. It didn't mind being sewn or mixed together.’28 Thus, old Rossum set about to imitate nature: first, an artificial dog, which took him several years and ‘resulted in a sort of stunted calf,’ and then the manufacture of a man.

The dog anticipates or is derivative of Pavlov's; the man reminds us of the creature in Frankenstein. Rossum is obviously cast in Frankenstein's image. Domin sardonically calls him ‘mad...the old crank wanted to actually make people’(13). Rossum's ‘bungling attempt’ occupied him for ten years-’It was to have been a man, but it lived for three days only.’ Then, we are told, ‘up came young Rossum, an engineer.... When he saw what a mess of it the old man was making, he said, `It's absurd to spend ten years making a man. If you can't make him quicker than nature, you might as well shut up shop'‘(pg.14).

Frankenstein-Rossum and his ‘monstrosities’ are pushed aside. Young Rossum is an engineer, not a physiologist, who says to himself: ‘A man is something that feels happy, plays the piano, likes going for a walk.... But a working machine must not play the piano, must not feel happy.’ As Domin concludes, ‘And to manufacture artificial

workers is the same thing as to manufacture...motors.' (Later, the mechanical metaphor is betrayed when we are told that 'there are vats for the preparation of liver, brains...and a spinning mill for weaving nerves and veins'; consistency was not Capek's strong point.)

All that the worker need do is to work: hence, a robot (from the Czech, robota, meaning work). The requirement is to reproduce 'the cheapest...worker with the minimum amount of requirements.' It is as if young Rossum were answering the desires of the classical economists and their 'iron law of wages.' Only robots are not people. 'Mechanically,' as Domin defines them, 'they are more perfect than we are, they have an enormously developed intelligence, but they have no soul'. In fact, we are told that the cost of producing a robot has been brought down within 15 years from $10,000 to $150!

Young Rossum, Domin goes on, 'then proceeded [like his father, though he has repudiated the old man] to play at being God.' He tried to make a superrobot. 'Regular giants they were. He tried to make them twelve feet tall. But you wouldn't believe what a failure they were'(pg.19). In this area Frankenstein seems to have done better.29

The robots are constrained not only by size, but by longevity. They have only a 20-year life span. They do not, however, die-which involves a consciousness of death-but simply 'get used up.' Though they appear lifelike-the young lady, in an amusing bit, mistakes a robot for a live human being, and the human for a robot-dissection proves that they are not. They feel nothing (reminding us of Descartes's views on animals-machines); consequently, one can be accused not of 'killing' them, but only of destroying a machine, just as wringing the neck of a chicken is not murder. All is well and peaceable in Rossum's factory.

Trouble enters this mechanical paradise, when, in Act I, Helena pities the robots and wants to treat them as 'brothers' and to 'show them a little love'-shades of Frankenstein! As befitting a play of 1921, the language is also of 'liberating' the robots: that is, the workers.

By Act II, Helena is married to Domin, ten years have gone by, and the robots number millions and millions. One of the other humans in the factory, Dr. Gall, under the influence of Helena, has begun to introduce modifications into the manufacture of some of the robots: pain, ostensibly so that they can withdraw their hand from dangerous operations; irritability, so that they begin to show defiance; and other such human attributes.

Capek's argument is really disingenuous. Humans are depicted as 'imperfect' machines. 'For example,' as an engineer explains, 'from a technical point of view, the whole of childhood is a sheer absurdity. So much time lost'. Humans obviously also waste time with sex. Their intelligence is less than what it might be. Hence, robots are created that are more intelligent and powerful than humans, who have no interest in sex, and are clearly superior. Yet, as soon as this is done, it becomes obvious that Capek considers them less perfect than men because they do not have feelings, such as love and fear.

The contradiction becomes clear as the play unfolds in the last two acts. Owing to Dr. Gall and Helena's meddling, a new species of robot is produced that soon starts to go ‘mad,’ and ends up in revolt against man. As the robot leader declaims to Helena: ‘You are not as strong as the Robots. You are not as skillful as the Robots’(pg.91-2). To her words about equality, he responds, ‘I want to be master. I want to be master over others’. He proclaims to his fellow robots: ‘We command you to kill all mankind. Spare no man. Spare no woman’ (pg.117).

The robots take over the island, and all humans are killed except one ‘last man,’ Alquist. Indeed, humans have already, as Dr. Gall noted earlier, ‘become superfluous’(98). The problem is, however, that the robots, too, are about to die out, for they cannot reproduce themselves. (In a moment of humanitarian fervour, Helena had destroyed the copies detailing the secret process of creating the robots, so as to prevent further manufacture and hence exploitation.) In the Epilogue, the robots command Alquist to rediscover Rossum's secret. However, much as he wishes to do so Alquist lacks the scientific ability. He prays, ‘Lord...if there are no human beings left, at least let there be Robots!-At least the shadow of man!’(pg.164).

At this point, a miracle occurs. Two of Gall's newest robots, a male and a female, enter. They are experiencing strange feelings-love, sexual longing, it appears. Also, ‘laughter-timidity-protection’(pg.154). To test them, Alquist proposes to take one of them into the dissecting room. When each is prepared to sacrifice him- or herself to save the other, Alquist knows that a new race has been born. ‘Go, Adam, go, Eve. The world is yours,’ he says in the last line of the play, ‘At least the shadow of man!’

I find the whole play incredibly muddled. In the last act and the epilogue, Capek is obviously writing as much about the workers' revolution in Russia as about the robots' uprising in Rossum's factory. On one hand, the play is a kind of Luddite-Frankenstein protest against human hubris in the making of machines: Helena's human maid, Nana, exclaims at one point, ‘All these new-fangled things are an offence to the Lord. It's downright wickedness. Wanting to improve the world after He has made it’(pg.101), and we are not meant to snicker. On the other hand, it seems to preach a certain idealism: that machines can free men from toil and thus allow him to reach for perfection. In Domin's proud, and possibly ironic, words, ‘He [the human] will not be a machine and a device for production. He will be Lord of creation’(pg.52).

Capek's identification of the robots with the workers of the world, led by Bolsheviks, is not without roots. Frankenstein's monster, too, was frequently identified by nineteenth-century readers with the rebellious masses. Thus, in the novel Mary Barton (1848), Elizabeth Gaskell writes of how ‘the actions of the uneducated seem to me typified in those of Frankenstein, that monster of many human qualities’ and Sir John Lubbock, a conservative scientist, speaking in the House of Commons around 1870 against liberal reform, gave as his reason that he ‘believed it would be impossible to control the Frankensteins we have ourselves created.’30 (Here they make the typical slip of calling the monster by its maker's name.) Feelings about the right ordering of the social world are thus projected onto the subject of robots.

The social and psychological springs of R.U.R. do not mesh smoothly. But even though its theme is unfocused, R.U.R. does successfully reflect our primordial feelings about automata, as both promise and threat. Capek's final message is ironic

and ultimately baffling, because he posits that the ‘new man’ of the future is a robot-but one that is just like a human in his feelings! Thus, Capek provides a null response to both the threat and the promise. But what is memorable about the play-or accounts of it-is the threat that, like Frankenstein's monster, unless they are first destroyed or emasculated, robots will usurp the world from humans.

R.U.R. was written before robots were used widely in industry and by an author who shows no evidence of having thought much about the science and technology animating them. Nevertheless, the play has achieved canonical status. I, Robot, by Isaac Asimov, is a much more thoughtful book-actually, a connected series of short stories-by an informed author, at a time when the presence of robots is becoming real; yet the book is mainly known only to sci-fi fans. It should be read, however, by anyone interested in probing our contemporary feelings toward robots.

Its protagonist is a woman psychologist, Dr. Susan Calvin (whose name, surely, is intended to symbolize the Protestant work ethic); with one or two exceptions, she is one of the few females in the book, with all the other humans and the robots apparently male. So much for the sex problem!

The first story, ‘Robbie,’ raises the familiar problems. Robbie is a non-talking ‘nurse-maid’ robot, for little Gloria. While the child loves ‘him’ and thinks of him as ‘a person just like you and me,’ her mother is actually jealous of Robbie, fears the machine-’it has no soul, and no one knows what it may be thinking’-and thinks ‘some little jigger will come loose and the awful thing will go berserk.’31 She insists the robot be removed and a collie dog substituted.

Gloria is inconsolable. Her father arranges for a tour of the premises of U.S. Robots and Mechanical Men, Inc., to show his daughter that Robbie is just a machine. When she breaks away to embrace Robbie, whom she sees on the assembly line, she steps in the path of a huge, lumbering tractor. While her father and the others are unable to act fast enough-’The overseers were only human, and it took time to act’-but Robbie, acting ‘immediately and with precision,’ saves his little playmate (pg.28). All is forgiven, and Gloria has her mechanical friend to take home.

A contrived tearjerker, the story is effective. It introduces us to our own fears, in a homey, humdrum way. We are told that the event occurred in 1998; as the stories continue, by 2002 mobile speaking robots have been invented, and, between 2003 and 2007, most of the world governments-presumably pressured by the mothers of innumerable Glorias-have banned robot use on Earth for any purpose other than scientific research.

As further protection, all robots are bound by ‘The Three Laws of Robotics’:

1-A robot may not injure a human being, or, through inaction, allow a human being to come to harm.

2-A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

3-A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

The remaining stories explore variations on one or more of these laws, their applications, and possible violations. Asimov is an interesting logician and rings the changes nicely. In the story 'Reason,' the robot Cutie pursues logic to its Cartesian conclusion, announcing 'I, myself, exist, because I think'(pg.51). Hubris overtakes this robot, who subsequently announces its conversion to the religion of 'The Master':

The Master, [it tells the two humans who are in charge of it,] created humans first as the lowest type, most easily formed. Gradually, he replaced them by robots, the next higher step, and finally he created me, to take the place of the last humans. From now on, I serve the Master (pg.53).

The rebellious delusion, however, turns out to be harmless, because Cutie still operates dials and graphs correctly, though claiming it does so in obedience to the Master; and, obedient to the Second Law of Robotics, does not harm humans. As one of its two tenders remarks, 'what's the difference what he believes'(pg.63). The incipient danger has been nicely damped down.

It breaks out again in a story in which a robot lies, against the strictest injunction. Finally detected by Dr. Calvin, using a clever piece of logic, it is destroyed. The dark shadow of the robot, however, has grown more menacing. In another story, a robot faced with conflicting demands behaves just as a human might: it suffers a nervous breakdown. Yet, Asimov tries to keep clear the distinction between humans and machines: the machine, he declares, is an 'idiot savante-it doesn't really understand what it does-it just does it'(pg.129).

The penultimate story, 'Evidence,' poses the 'difference' question most squarely. Is the lawyer Stephen Byerley, running for high political office, a man or a robot who looks exactly like a man? His opponent accuses him of being inhuman, and offers as proof that he never is seen eating. Byerley responds that his habit of eating in private is probably neurotic, but not inhuman. The test finally comes in a public debate when a man emerges from the audience, taunts Byerley, and says 'Hit me,' pointing out that a robot can't violate the First Law and harm a human. Byerley punches him, thus proving his 'humanity,' and, of course, wins the election.

Only, as it turns out (though Dr. Calvin alone comes to know), Byerley actually is a robot. Created by a crippled human to perform in his place, Byerley has simply struck another robot, cleverly planted in the audience to rise and challenge the original humanoid robot. When Dr. Calvin's colleague is queried about the possibility of such a humanoid robot, he reluctantly admits that

by using human ova and hormone control, one can grow human flesh and skin over a skeleton of porous silicone plastics that would defy external examination. The eyes, the hair, the skin would be really human, not humanoid. And if you put a positronic brain, and such other gadgets as you might desire inside, you have a humanoid robot' (pg.159-60).

Asimov is not dismayed by this possibility. Like his fictional creation, Dr. Calvin, Asimov believes that robots are ‘a cleaner better breed than we are’(9). They are decent and logical entities, who as civil executives and ‘World-Co-ordinators’-Byerley, for example-will run the world and bring peace and prosperity to mankind. Whereas ‘humans are fallible, also corruptible,’ machines are only subject to mechanical failure, not wrong results: that is, if fed the correct data.

Like everyone writing about robots, however, Asimov is also ambivalent. Humans, he seems to be saying, still possess a creativity denied to machines.

The Machine is only a tool after all, which can help humanity progress faster by taking some of the burdens of calculations and interpretations off its back. The task of the human brain remains what it has always been; that of discovering new data to be analysed, and of devising new concepts to be tested (pg. 187).

Yet, on the very last page of I, Robot, the machine appears as Providence, superior to humans but clever enough to hide its superiority so as not to injure human pride. (Earlier, we have seen Cutie making an open avowal of superiority-a clear sign of a kind of madness.) The books end with Asimov's message:

How do we know what the ultimate good of Humanity will entail? We haven't at our disposal the infinite factors that the machine has at its! Perhaps, to give you a not unfamiliar example, our entire technical civilization has created more unhappiness and misery than it has removed. Perhaps an agrarian or pastoral civilization, with less culture and less people would be better. If so, the Machines must move in that direction, preferably without telling us, since in our ignorant prejudices we only know that what we are used to, is good-and we would then fight change. Or perhaps a complete urbanization, or a completely caste-ridden society, or complete anarchy, is the answer. We don't know. Only the Machines know, and they are going there and taking us with them (pg.192).

It is a wishy-washy conclusion to an intriguing group of stories, in which Asimov cleverly explores both our logical and illogical attitudes toward robots. I have not mentioned, for example, his handling of the ‘Fundamentalists,’ who would destroy all machines, or his assumption that in the mid-twenty-first century, robots are still under the control of private, capitalistic enterprises, competing unscrupulously with one another (the cost of a robot is, in this book, $30,000). Overall, however, the book is a provocative rehandling-generally optimistic-of the themes we have been pursuing from Andersen's nightingale through Capek's Rossum's robots.

In spite of the length of this article, I have only touched on the wealth of literature relating to automata. The subject seems to crop up everywhere, in almost everything one reads. Some light on its ubiquity may be shed by ‘The Uncanny,’ a strange and difficult paper by Sigmund Freud.32 Here Freud points to what may be involved, psychologically, in the fear of the inanimate-of automata. Discussing E.T.A. Hoffman's story, ‘The Sandman’ (later part of Offenbach's opera, Tales of Hoffman), Freud argues that the feeling of the uncanny arises where we are in doubt as to whether an apparently animate being-an automaton-is really alive, or not.

We need not follow Freud in his specific and tortuous analysis of the story in terms of castration fears, or in his general analysis of the uncanny in terms of animistic mental activity. For our purposes, we need only be inspired to realize that automata, mechanical dolls, and machines of all sorts awaken special undefined fears in us. Does the machine represent a part of ourselves of which we are afraid? Do we project into it our secret, and most forbidden, desires? A moment's reflection on our feelings toward robots, Pygmalion-like statues, or Frankenstein monsters (though this is, as stressed, in fact a flesh-and-blood creation) will confirm the extent of our emotional involvement, even if not its exact nature.

With this as a psychological context, I can use the examples given in this chapter to make the following general points. What are variously called automata, or androids, or robots, are conceived by man as originating either at the hands of gods (for example, the Delphic oracles), or by man using magic (for example, the automata or golems of the Hermetic tradition), or by man using science (for example, the clockwork nightingale, Frankenstein's monster, and Capek's and Asimov's robots). (It would be nice to think of this as a chronological progress, but ancient Chinese scientists obviously used clockwork, and the followers of Hermes Trismegistus used magic very early on; what we find, therefore, is a recurring juxtaposition of the animating forces.) The created figures are either primarily biological or mechanical; flesh and blood or clockwork-machines, animated by a spark or wound up.

However created, whatever the material, they all pose the same compulsive question: how do they differ from humans, or, more simply, what is a human? This is the ‘uncanny’ feeling analyzed by Freud. So, too, they all arouse in us the same range of ambivalent reactions: the sense of a perfection and infallibility to which we aspire-the angel in us-and the sense of the destructive and degrading in us-the ape in us.

Something new is now emerging: the robot as an industrial reality. Still, the same feelings seem to be attached to it. Thus we are told that when a Japanese worker was crushed in a robotics accident, arising from his being in a restricted area and failing to notice that he was in the automatic path of a transport robot (and no ‘Robbie’ to rescue him!), the incident was reported in the press as ‘though it had been a robot uprising.’33 Will these feelings change as familiarity breeds boredom? In the movie 2001, Hal the computer rebels; will the memory fade from our dreams?

The fact is that our feelings toward the robot-automaton are caught up anew in our feelings toward its new version, the computer. The robot now becomes the tool-really, the body-by which the computer-a ‘brain’-can ‘move’ and take on ‘animated’ form.

Automata now take the shape of artificial intelligence machines.34

Notes

This essay is adapted from Chapter 3 of Bruce Mazlish’s book, *The Fourth Discontinuity: The Co-Evolution of Humans and Machines* (New Haven: Yale UP, 1993). Thanks to Yale UP for granting permission for the adaptation. I would also like to acknowledge the assistance provided by Güven Güzeldere, without whom this article would not have appeared in its present shape. Thanks also to Stefano Franchi and Laura Kerr for editorial help.

1 See Joseph Needham, *Science and Civilization in China*, vol. 4, part 2 (Cambridge: Cambridge UP, 1975) 54. This book is a mine of information on the subject of automata, as well as on its more general subject. Further on automata, compare Albert Chapuis and Edouard Gélis, Le *monde des automates* (Paris: Chapuis, 1928).

2 Needham, vol. 2, 53. Comparison with statements by LaMettrie spring quickly to mind.

3 Quoted in Julian James, *The Origin of Consciousness in the Breakdown of the Bicameral Mind* (Boston: Houghton, 1976) 336.

4 For one such attempt, though a brief one, see John Cohen, Human Robots in Myths and Science (London: Allen & Unwin, 1966).

5 Needham, vol. 2, 165.

6 Quoted in Needham, 164.

7 Francis A. Yates, 'The Hermetic Tradition in Renaissance Science,' *Art, Science, and History in the Renaissance*, ed. Charles S. Singleton (Baltimore: The Johns Hopkins UP, 1967) 258, 255.

8 Yates, 257.

9 Quoted in Yates, 259.

10 Radu Florescu, *In Search of Frankestein* (Boston: New York Graphics Society, 1929) 233. This is a marvelous work, well printed and illustrated, and, at the time I bought it, a wonderful buy. Compare the article by Michael Uhl, 'Living Dolls,' Geo (July 1985), and its quotation of one observer who delicately noted that Vaucanson's duck duplicated the process of digestion in full view of the spectators, 'ending the digestion process as naturally as it began'(86). Thus, long before Pavlov, the idea of a viewable pouch in the stomach was employed, not in a dog, but in an automaton.

11 In the seventeenth century, Sir Kenelm Digby, member of the Royal Society, had already declared that birds were machines, whose motions when feeding their young or building their nests were no different from the striking of the clock or the ringing of an alarm. See Keith Thomas, *Man and the Natural World* (New York: Pantheon, 1983) 35.

12 Folk-lore and Fable: Aesop, Grimm, Andersen, The Harvard Classics, ed. Charles W. Eliot (New York: P.F. Collier, 1909) 325. The next quotation is from page 326.

13 Eliot, 328.

14 Eliot, 329.

15 There is some evidence for this origin in Needham, 157.

16 See Florescu, 223-225, for this and other details.

17 Florescu, 329.

18 Giovanni Aldini, On Galvanism (London, 1803) 194. Quoted in Michael Kita, ‘Mary Shelley's Frankenstein: Two Contexts,’ unpub. ms. I owe to it inspiration for some of the above, and what follows on Natürphilosophie.

19 See Florescu, 65 ff., for his tracking down the possible influences on Mary, who supposedly visited a Castle Frankenstein in the Rhine country, inhabited in the eighteenth century by a Konrad Dippel, an alchemist accused of strange experiments.

20 Mary Shelley, *Frankenstein* (New York: Dell, 1975) 46.

21 In fact, Mary Shelley herself, in a subsequent novel, *The Last Man* (1826), makes the connection when she writes about man as an ‘automaton of flesh...with joints and strings in order.’ Quoted in William A. Walling, Mary Shelley (New York: Twayne Publishers, 1972) 93.

22 Shelley, Frankenstein, 7. The next quotation is from page 12.

23 Shelley, Frankenstein, 51.

24 William Godwin, *Enquiry Concerning Political Justice, and Its Influence on Morals and Happiness*, 3rd ed., vol. 2 (London, 1798) 528.

25 Baum's own identity is not as simple as it might at first appear. Some writers on Baum see him as a social critic and a populist; see, for example, Henry M. Littlefield, ‘The Wizard of Oz: Parable on Populism,’ *American Quarterly* 16.1 (Spring, 1964). For an overall treatment, see Raylyn Moore, Wonderful Wizard Marvelous Land (Bowling Green, Ohio: Bowling Green UP, 1974), who suggests that ‘for the first time in the history of the fairy tale, Baum produces monsters which are mechanical, in whole or in part’(143). For a number of critical essays on Baum, see Michael Patrick Hearn, ed., *The Wizard of Oz* by L. Frank Baum (New York: Schocken Books, 1983); also Martin Gardner, ‘The Royal Historian of Oz,’ *Order and Surprise* (Buffalo, NY: Prometheus, 1983).

26 L. Frank Baum, *Ozma of Oz* (Chicago: Reilly & Lee, 1907). All further references to this edition are cited within the text.

27 In the New York Times, February 11, 1982, there is a claim that ‘robot’ was a term coined by Karel's brother, Josef.

28 Karel Capek, R.U.R., trans. Paul Selver (Garden City, NY: Doubleday, 1923) 10-11. All further references to this edition are cited within the text.

29 In fact, neither Frankenstein nor God could have created a 12 foot man, for it violates a known law concering size and shape, wherein volume grows more rapidly than surface. For details, see Stephen Jay Gould, ‘Size and Shape,’ *Ever Since Darwin* (New York: Norton, 1977). Domin himself has a glimpse of this fact when he adds, ‘For no reason at all their limbs used to keep snapping off’(16).

30 See Florescu, 14.

31 Isaac Asimov, *I, Robot* (New York: Fawcett Crest, 1970) 16. All further references to this edition are cited within the text. (The title might be intended to suggest either an ironic or an egoistic identification with the author, who is frequently cited as 'I. Asimov.') Asimov's more recent book *The Robots of Dawn* (New York: Ballantine Books, 1983) is, unfortunately, not quite up to the standard of its predecessor, being rather repetitious and crude in its attempts at salaciousness. *I, Robot*, itself, however, is a classic.

32 Sigmund Freud, 'The Uncanny,' *Standard Edition*, vol. 17.

33 *New York Times Magazine*, January 10, 1982: 62.

34 In the fourth chapter of my book, *The Fourth Discontinuity*, I follow up on these points with a discussion of the Industrial Revolution, considering it as a quantum leap in the relationship humans have with machines. In its first phase in the early nineteenth century, artificial intelligence machines as such do not figure in production. Instead, the machine basically replaces manual labor. However, as I show later in chapter seven on Babbage, the artificial intelligence machine is conceptualized and even developed by him, in his arithmetical mill, around 1822-1832, as part and parcel of the mechanizing impulse of the Industrial Revolution. It takes about a century and a half, however, before the computer and the robot (our modern automata) emerge as prime 'movers' in the continuing industrial revolution, substituting for brain as well as brawn.