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Seventeenth-century self-movers

The notion of an *automaton*, as it is employed in the natural philosophy of Descartes and his closest followers, has three main components. None of them is new; what is new in early modern philosophy is the uses to which this old notion is put, and the idiosyncrasies into which its components are combined by subsequent philosophers. The thaumaturgic element is never entirely suppressed; but the more down-to-earth usage exemplified in antiquity by Aristotle's references predominates. The automaton is quite often the opposite of wonderful: phenomena that might excited wonder are proved to be unworthy of it, just by showing that they are the productions of an automaton.

The automaton is, first of all, a machine, and therefore an artifact, human or (if the metaphor becomes literal) divine. It offers a model of intelligibility—to use Peter Dear's term—for a certain class of natural phenomena, namely those we find in living things. But Descartes wants from it something more. In Descartes' usage, a machine is that which makes itself available not just to "mechanical" explanation, but to a *complete* explanation, an explanation that makes all others superfluous.

Not all machines, of course, are automata. Two further components figure in the notion. One is that automata are typically *imitative*. From the *automata thaumata* of Aristotle's *De Motu animalium* to the nymphs of Salomon de Caus's fountains, many automata are likenesses, partaking both of the iconic (to use Peirce's term) and the symbolic. Moving sculptures proceed moving pictures by over two thousand years. They succeeded if they convinced their audiences that they could do what their prototypes did—where the doing is typically restricted to some few sorts of act. The wind-up mouse skitters across the floor like a real mouse; but it does not eat, nor does it seek the

company of other mice, and avoid that of cats. Even Vaucanson's famous duck was far from doing all that a real duck can do. Moreover, as the example of the harpsichord player of [¤Riskin¤] the act of the automaton typically falls short of duplicating the act of its prototype; instead it *portrays* that act, it acts partly in the theatrical sense of that word.

The third component of the notion is *self-movement*. Kenelm Digby writes that in animals, the "parts" and "members" "conspire together, to effect any thing that may be for the use and service of the whole"; we therefore find them to have

> perfectly the nature of a mover and a moveable: each of them moving differently from one another, and framing to themselves their own motions in such sort as is most agreeable to their nature; when that part which sets them on work hath stir'd them up,

and so we call them an automaton, a self-mover, a "Living Creature".[1] Self-movement is a bit of a puzzle, especially in an Aristotelian setting; but a Cartesian physicist should be no less troubled. The Aristotelian principle according to which *omne quod movetur ab alio movetur* can be construed as a version of the first Law of motion. Digby here is echoing Aristotle's solution to the puzzle, which I'll come back to: in living things, self-movement consists in one part's moving another.

[What follows.]

1. Digby, Kenelm, *Of bodies and of mans soul to discover the immortality of reasonable souls : with two discourses, Of the powder of sympathy, and, Of the vegetation of plants* (1669), 259. [¤ Check earlier editions ¤]

1. Imitation

The well-known opening of the *Treatise on man* proposes that the inhabitants of the world Descartes has asked us to imagine in earlier chapters of the so-called *Traité de la lumière* are composed, as we are, "of a soul and a body". But first of all we are to consider the body (AT 11:119).

> I suppose that the body is nothing other than a statue or machine of earth, formed expressly by God so as to render it as similar to us as possible.

It will resemble us not only outwardly but inwardly, having all it needs to

> walk, eat, breath, and in sum imitate all those functions of ours that can be imagined to proceed from matter and to depend only on the disposition of the organs.

All things are possible to God, but just in case his reader balks at the suggestion that *all* the functions that "can be imagined to proceed from matter" could be imitated by a machine made of extended stuff, Descartes notes that humans have made fountains and mills that move of themselves, and supposes that however complicated we see human machines to be, those of God could be still more so—indeed infinitely more so, given the infinite—the actually infinite—divisions of matter.

To this one total likeness all the partial likenesses that follow are subordinated. The nerves, for example, are compared to the pipes connected to fountains like those "in the gardens of our kings"; respiration, "and other acts that are ordinary and natural to [the body], and that depend on the flow of the [animal] spirits" are like "the movements of a clock or mill" made regular by a consistent current. External objects acting on the organs of sense are like intruders into the garden who, without realizing it, cause statues connected to the fountains to move in their presence (AT 11:131).

The use of comparisons of this sort is traditional. More novel is the imagining of a whole body or machine into which are inserted, the targets of comparisons such as that of nerves to pipes. [¤Baglivi.¤] Moreover the intention with which the machine is designed is not, as

in Aristotle or Galen, the well-being of the organism it serves, but rather that of imitating all our *functions*, or those at least that are owing to matter alone, and whose distinctive feature is that they go on in us without our thinking of them (¤*PA*¤).

The project of imitation taken by itself is not new. Florent Schuyl, in his preface to the first edition—a Latin translation—of the *Treatise on man*, enumerates the usual suspects in the history of automata, not omitting to mention Aristotle himself in *De Motu*,[2] each of them the more or less marvelous and celebrated figure of some animal or human. The novelty of Descartes' *Treatise* consists in its use of the imitative figure as a means to knowledge of the thing said to be imitated. It is imitated, we know, by a *machine*. That the moving sculpture is a machine places it, as we'll see, under the rule of Cartesian mechanism. The point of its being an imitation, on the other hand, is not so clear.

Here I distinguish between the part-by-part comparisons, such as that of the nerves to pipes, and the imitation of the whole body by the whole machine. The point of part-by-part comparisons—so Charles Perrault tells us in his *Méchanique des animaux*—is that the "instruments we can see" in the body have been for us the object of

> experiences which, being mostly taken from Mechanics, are not equivocal and uncertain like all the others used to divine the causes and ways of acting of other Beings [*sc*. other than animals; Perrault holds that animals are easier to know than, e.g. the heavens] (Perrault *Méchanique des animaux*, in *Essais de physique* (Paris: Coignard, 1680) 8).

As Noga Arikha puts it in her essay on form and function in early modern physiology, the objects of mechanics "were characterized by a transparency of function" (Arikha 2006:176). Once you have identified a bone-and-joint combination as a lever and fulcrum, nothing further need be explained.

The epistemic role of the imitation of the whole body by the whole machine, on the other hand, could easily be of one unknown by another. If God really has made a moving sculpture that imitates the human body as closely as possible, there is no reason to think that the sculpture will be more accessible to the natural philosopher than its

2. La Forge *L'Homme de René Descartes* (Paris: Fayard) 399.

model. Suppose by way of comparison that we have set up a neural network to recognize faces; it is characteristic of such networks that there need be no straightforward correlation between the parts of the network and features of faces. The network, like us, can re-identify faces, but *how* it does so we may understand no better than we understand our own capacity.

This is a way of saying that to have made a thing is not necessarily to know how it works. *A fortiori* to speculate on a thing that God, and not we, has made need not give us purchase on the way it accomplishes its functions. But the maker, though not perhaps master of the thing made in that respect, may yet be in a position to rule out certain possibilities. Thus Boyle, when he synthesized a substance indistinguishable from saltpeter from nitre and "spirit of saltpeter", thought himself justified in inferring that naturally occurring saltpeter did not contain a new form—a *forma mixti*—but only an arrangement of the two substances from which Boyle had made a new substance "simulating" saltpeter.[3] Similarly the neuroscientist is entitled, it would seem, to infer that since the network, composed of wholly material stuffs, is capable of recognizing faces, explaining that capacity in humans need not require appeal to an immaterial soul or to non-physical powers.

The purpose of Descartes' speculation, then, is to persuade us that a mechanical body can operate as a human body does, and thus that it can have the *capacities* of a human body; but since we have supposed that God put nothing into the mechanical body except parts having figure, size, and motion, we may infer that nothing more *need* be attributed to the human body. That, of course, doesn't license the inference that the human body in fact has no special powers such as the Aristotelians attributed to it. But it does greatly weaken arguments that infer such powers merely from the operations of the body.

Part-to-part likenesses seem to be on firmer ground. But as Noga Arikha notes, in the case of brain function, inferences from form—

3. Margaret G. Cook, "Divine artifice and natural mechanism: Robert Boyle's mechanical philosophy of nature", *Osiris* 2nd series 16 (*Science in theistic contexts*) (2001) 133–150, here 147.

that is, from the comparison of parts of the body to more-or-less simple mechanical complexes, including homologous parts of animals—to function proved to be uncertain. William Bynum, here cited by Arikha, argues that the "anatomical method", by which function is inferred from form, did not succeed, in its application by Thomas Willis to the rational powers of the human mind, in finding a place for them. Candidate structures could all be found in reasonless brutes, and though Willis eventually locates the seat of reason in the corpus callosum (having rejected Descartes' proposal) his position remains ambiguous: the differences one would need to find to support the well-known differences in capacity between humans and animals seem not to exist, and yet Willis continued to search for a physiological basis for properly human capacities.[4]

> But more particularly, we may conceive the middle or Marrow part of the Brain, as it were the inferiour Chamber of the Soul, glased <25> with dioptric Looking-Glasses; in the Penetralia or inmost parts of which, the Images or Pictures of all sensible things, being sent or intromitted by the Passages of the Nerves, as it were by Pipes or strait holes, pass first of all thorow the streaked Bodyes, as it were an objective Glass, and then they are represented upon the Callous Body, as it were upon a white Wall; and so induce a Perception, and a certain Imagination of the thing felt: Which Images or Pictures there expressed, as often as they import nothing besides the mere Knowledg of the Object, then by and by further progressing, as it were by another waving, from the Callous Body towards the Cortix or shell of the Brain, and entring into its folds, the phantasie vanishing, they Constitute the memory or remembrance of a Thing (*Two discourses* 24–25).[5]

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4. Bynum, William F. "The anatomical method, natural theology, and the functions of the brain". *Isis*, 64. 4 (Dec 1973): 444-468, esp. 458–459.

5. The passage continues: "But if the sensible species being impressed on the Imagination, promises any thing of Good or Evil, presently the spirits being Excited, respect or look back upon the Object, by whose appulse they were moved, and for the sake of embracing or removing it away, by other spirits flowing within the Passages of the Nerves, and successively by others implanted in the Members and moving Parts, they swiftly give their Commands of performing the respective motions. So the Sense brings in the Imagination; this the Memory or the Appetite, or both at once". Thomas Willis, *Two discourses concerning the soul of brutes which is that of the vital and sensitive of man. The first is physiological, shewing the nature, parts, powers, and affections of the same. The other is pathological, which unfolds the diseases which affect it and its primary seat; to wit, the brain and nervous stock, and treats of their cures.*

Descartes leaves aside the conceit of imitation when he returns to physiology in the *Description of the human body.* In that work the human body *is* a machine, without qualification. He acknowledges the difficulty in believing "that the disposition of the organs alone would be sufficient to produce in us all the movements not determined by Thought"; nevertheless he judges that the mere description of the parts and explication of the functions of the body will persuade the reader (*Description* §5, La Forge 133).

Part-by-part comparison remains. But a comparison of parts presupposes only the mechanical intelligibility of the mechanisms appealed to. The supposition of imitation is irrelevant, and the question of self-motion need not be addressed.

2. Machine

The automaton, as I have said, is a machine, hence an artifact. The body of a human being in the new world of Descartes' physics is supposed at the outset to be a "statue or machine". In the peroration with which the *Treatise on man* ends Descartes invites the reader to "consider that all these functions"—a long list of which he has just given—"imitate as perfectly as possible those of a true man", and that they

> follow naturally, in this machine, from the mere disposition of its organs, no less no more than do the movements of a watch or some other automaton from the disposition of its counterweights and wheels,

from which it is supposed to follow that no animal or vegetative soul, nor any principle of life other than the blood, agitated by a fire which differs not at all from fire in nonliving things (AT 11:202).

I quote this familiar passage because it brings together in a few words the two themes I want to discuss under the heading of "the automaton as machine". The first is suggested by remarks in a paper of Sylvia Berryman on ancient automata: it is the question of the

London, 1683. · http://gateway.proquest.com.libproxy.wustl.edu/openurl?ctx_ver=Z39.88-2003&res_id=xri:eebo&rft_id=xri:eebo:citation:99831033

practicability of the mechanical models employed in explanation.[6] The second theme comes from a paper by Jean de Groot on the *Mechanica* attributed to Aristotle.[7] Mentioning me, he notes that in my view mechanical explanations were intended to supplant other sorts of explanation—in particular those that appeal to *potentiæ* or to non-mechanical dispositions (66). The question he raises is whether the appeal to machines, or more generally to mechanical principles like the law of the lever could not instead be in support of an appeal to powers or for that matter to ends.

Berryman identifies what I will call, to avoid confusion, *mechanistical* conceptions of natural things as those which use ideas from the discipline of mechanics. She notes that in the usage of natural philosophers and historians the terms *mechanistic, mechanical* and so forth are "restrictive" (346). To be a mechanistic in the early modern sense is, on the one hand, to put forward or promise certain sorts of explanation; and to refrain from other sorts. The mechanist prefers agency to finality and factive to dispositional properties ("five foot too" is better than "eyes of blue", and both of these are much better than "adorable"). Breakdown into interacting parts (on the model of the dynamics of the pineal gland) is preferable to the analysis of capacities (on the model of *De Anima* II). A thoroughgoing mechanist not only prefers the ones to the others, but regards the others as ineligible: concepts other than mechanistic are unintelligible, confused, superfluous (as 'dormitive virtue' is said to be).

A *mechanistical* conception (as I said, this is my label, not hers) is one whose ideas "are derived from interaction with real technology"—in antiquity the technology described in works on the "mechanical art", *ta mēchanika* (347); mechanistical explanations are restricted to "the techniques that are available in the mechanics of the day". To borrow an example from Jean de Groot's paper: Greek boats had rudders similar to those on rowboats and other small

6. Sylvia Berryman, "Ancient automata and mechanical explanation", *Phronesis* 48.4 (2003) 344–369.

7. Jean de Groot, "*Dunamis* and the science of mechanics: Aristotle on animal motion" *Journal of the history of philosophy* 46.1 (Jan 2008) 43–67.

vessels now: they consisted of a relatively short handle attached to a board immersed in the water at the stern. Aristotle observes that a small movement of the rudder produces a "wide deviation at the plow" (*De motu anim.* 701b27). That principle thus illustrated, which de Groot calls the "moving radius principle" (47–48), though as we'll see it can be expressed in purely geometric terms, has an evident basis in technologies involving levers, wheels, and other simple components used in Greek machines. Aristotle restricts himself, to use Berryman's phrase, "to explanation by the means *seen to work*" in mechanics—that is, in an art devoted to making real devices. Some leeway is admissible: for example, I think she would allow for devices employing infeasibly high gear-ratios. But "a mere gesture in the direction of technology is not enough" (349).

Referring to my work on Descartes, Berryman notes that I briefly consider whether the contraptions that Descartes and others imagine to be operating in livings could do so, even if we grant them the underlying physics. Putatively mechanistic explanations, unless they respect the limits of *mechanistical* explanation, risk being little better than appeals to *some way or other* of carried out the function in question, no better grounded in experience than appeals to powers or qualities. If you suppose, as Descartes does, that jets of fluid proceeding from the pineal gland and encountering the walls of the chamber surrounding the gland will produce back-pressure on the gland, then in (and perhaps by Descartes' own hydrodynamical principles) you are crediting, in Berryman's phrase, your materials "with properties they do not have, and could not plausibly seem to display in real constructions". This would be materialist but not mechanistical.

In *De motu* Aristotle writes that "the movement of animals is like that of *automata* [or puppets] which move when a small movement occurs, loosening their strings and having their pegs strike against each other […]. They have functioning parts [*organa*] of the same kind, the sinews and bones" (701b1–10). Berryman denies that Aristotle here is offering a mechanistical account of animal locomotion. On the contrary he doesn't think that animals do or could "work like that"; the point of the comparison is to show that in

animals impulses from without are not merely transmitted but transformed, so that for example in being fearful we are not merely being pushed around by the thing we fear; on the contrary, from a very small external impulse very large motions involving the entire body may follow.

The actual causal story Aristotle tells invokes *pneuma* or spirit, "a theoretical substance whose properties are merely stipulated". There are no spirits in the technology of boat rudders or toy carts; Aristotle has left mechanics behind (359).[8]

The moving radius principle is the principle that, given concentric circles rotating around their common center, the ratio of the distance travelled by a point on one circle to the distance travelled by a point on another is proportional to their radii. It was applied in a variety of situations. De Groot emphasizes that in Aristotle's uses of it the principle or something analogous to it was applied not only to local motion but to alterations, for example, to heating (62, 64; cf. *De motu* 701b25–30: an alteration in the heart even in an "imperceptibly small part of it" produces a big difference in the body—shuddering, for example, or trembling). I think that Berryman would deny that the extension of the moving radius principle to alteration was any longer mechanistical. But I think that de Groot and Berryman would agree that in appealing to the principle, and in comparing animals to *automata*, Aristotle was not proposing a theory of their bodily changes that was mechanistic in the early modern sense.

I want to draw out two points from this discussion. The first is that I think early natural philosophers recognized something like Berryman's distinction between mechanical explanations based in experience with real machines and "fairy-tale" or "in principle" explanations that, though they respect the limits of mechanism (that is, they do not invoke features of bodies other than figure, size, motion, and impenetrability), do not trouble themselves with asking

8. Berryman contrasts what she calls "mechanistic" explanations and conceptions with "materialist". A materialist may invoke all sorts of infeasible, magical powers and entities, so long as they reside in bodies; a mechanist may appeal only to the entities referred to in the "art of machines" of her time.

whether their constructions could work "like that". If not, then they are at best mistaken, at worst covert appeals to something like magic.

Certain of Descartes' explanations begin to look only speciously mechanistic because they fail the test of feasibility; in particular, the animal spirits begin to look more and more unphysical as the seventeenth century comes to a close. Even those who accepted them could no longer believe that they could function as according to Descartes they must. One might say that he was the victim, at the hands of Newton, Huygens, and other successors of a rapidly improving acquired physical intuition, the intuition by which a natural philosopher could grasp whether a putative mechanism could really work like that.

Nevertheless the invocation of machines, which because they model living things, are perforce automata in the sense of being self-movers, had accomplished one important task in natural philosophy. Mechanistical or not, Descartes' constructions persuaded a first generation of natural philosophers that the "mechanical philosophy"—the philosophy that restricted itself to figure, size, and motion (and impenetrability, added later) could in principle account for all the phenomena that the Aristotelian philosophy had accounted for.

This it did in part by forcing the question. Berryman and de Groot agree that for Aristotle giving a mechanistical account does not at all preclude appeal to powers or ends. I think that that is true not just for the ancients or the early moderns but sempiternally. Descartes and the other opponents of the Schools could persuade their contemporaries to give up the types of explanation (other than mechanistical) used in Aristotelian natural philosophy only by making it seem as if mechanist explanation *competes* with other types of explanation, so that the philosopher must choose. Automata, as machines—that is, as objects of knowledge *stipulated* to have only "mechanical" properties, and whose operations, therefore, could be explained only in terms of those properties and the laws governing their determination—provided one means of doing so, effective provided that one accepts the *identification* of the object of knowledge,

the "statue or machine" with which the *Treatise on man* begins and actual human bodies.

The route to that identification is imitation—thus the first aspect of the automaton does have a role—but of a special sort: the automaton-object, stipulated to have only mechanical properties, *simulates* the operations of the real body: it does the same things. Once the identification is achieved, the automaton no longer imitates the body: it *is* the body, and the features attributed to are held to be real features of the body whose presence *explains* what the body does by constituting the causes of what it does. It's not merely *as if* your brain contained animal spirits whose movements would be part of the cause of your motions; your brain really does contain them.

But the identification of the automaton-object and the body it simulates forces the sort of question that Berryman says must be answered in mechanistical explanation: namely, could it work like that? We see, for example, Borelli asking just how much force is exerted by the muscles, and trying to estimate the force required for various operations like flying—something Descartes never even proposed.[9] We see Willis and Steno asking whether the anatomy of the human brain is such that the pineal gland could work as it is supposed to by Descartes (the answer is no). The appeal to machines—not part-by-part comparisons but rather the imitation of the whole body by an automaton—was perhaps a necessary step toward a better physiology, but even if necessary it was also bound to be transitory.

9. Mersenne and Galileo are the pioneers, not Descartes.