Techné: Research in Philosophy and Technology ISSN: 1091-8264
16:2 (Spring 2012): 138–186 DOI: 10.5840/techne201216213

Dissolving Nature: How Descartes Made Us Posthuman

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Abstract: This paper is an enquiry into the philosophical fault-line that leads from mechanicism to posthumanism. I focus on a central aspect of posthumanism: the erosion of the distinction between organism and machine, nature and art, and the biological and engineering sciences. I claim that this shift can be placed in the seventeenth century, in Descartes's biology. The Cartesian fusion of the natural and technological opened the door to distinctly posthuman understandings of the living body, its relation to technological extensions, and the possibility of its drastic alteration. Descartes's mechanicism demanded a reconceptualization of bodily boundaries, organismic unity, natural finality, causation, and bio/technological instrumentality; all of which Descartes boldly theorized in terms of the wondrous technologies of his day. This radical proposal obscured the possibility of thinking the human as ontologically unique, or as having an ideal unity. This paper will examine the posthuman ramifications of these aspects of Descartes's philosophy.

Key words: Descartes, posthumanism, automaton, mechanicism

Introduction: Descartes and Posthumanism

Engineered animals, clones, intelligent machines. Virtual identities, designer babies, artificial life. Organ farming, modified foods, life support machines. Cyborgs, medical miracles, reproductive technologies. Robocop, Dolly, Deep Blue, the Human Genome Project, FrankenFoods. Stem cell research, distributed cognition, life-forms and genes copyrighted as technical creations. Forests with human rights, and machines that live and evolve. The dissolution of nature, the artificial and the human as meaningful categories.

Welcome to posthumanism, a historical condition typified, in the words of Katherine Hayles, by the abolition of any "essential differences or absolute de-

marcations between bodily existence and computer simulation, cybernetic mechanism and biological organism, robot teleology and human goals" (Hayles 1999: 3). Similarly, Joseph Tabbi refers to "a postmodern culture that no longer respects romantic oppositions between mind and machine, organic nature and human construction, metaphorical communication and the technological transfer of information" (Tabbi 1995: 1).

Posthumanism is a term that attempts to capture a range of phenomena that cuts across philosophic, scientific, social, political, ethical and cultural dimensions. As a field of study, it advances neither a doctrine nor a theory, embracing a wide range of incommensurable, and often contradictory, ideas and programs. Despite this open-endedness, I'll use the term as a useful way of articulating a set of contemporary problems that share common historical origins, and strong conceptual and cultural connections.

Central to posthumanism is the notion that the human is a historical, contingent entity; one that recent technological developments are promising, or threatening, to alter beyond recognition. This should be seen as part of a larger question concerning how the human is defined in relation to other categories, such as nature, culture, reason and life. Thus, posthumanism has emerged as an attempt to think through the arbitrariness of boundaries between organism and machine, matter and information, mind and external technological supports, the social and the biological, human and non-human agency, and the living and the artificial (to cite some key battlefronts.) Our unprecedented technological power to manipulate, create and alter living things is posing urgent political and ethical questions, crystallizing around issues such as biotechnology, the manufacture of human embryos, life extension, and genetic manipulation. As Catherine Waldby puts it, the disorienting proliferation of natural-technological hybrids is "increasingly demanding public conceptualization beyond the terms of humanist bioethics" (Waldby 2000: 45).

The following is an historical and philosophical enquiry into an essential aspect of the posthuman condition: the erosion of the distinction between organism and machine, and nature and artifice. I claim that this shift can be traced back to a specific historical origin: the mechanization of biology in the seventeenth century, which first posited a metaphysical identity between living organisms and machines. This radical ontological realignment was at the epicenter of a series of scientific and cultural developments that led to posthumanism. More precisely, this critical junction can be placed in the physiology and metaphysics of René Descartes, the philosopher who first extended the mechanization of the heavens into the heart of life.

The Cartesian fusion of the natural and the artificial opened the door to distinctly posthuman understandings of the living body and its relation to technological extensions, as well as suggesting the possibility of redesigning nature following the paradigm of engineering. Descartes's writings on physiology and optics are a kind of laboratory in which the theoretical and practical amalgamation of machines and organisms is rehearsed, in at least two senses: (a) the prosthetic and instrumental enhancement of the body, its technological production, extension and mediation; and (b) the functional integration of machines and organisms in medical, industrial, military, and other contexts.

Descartes's biology offered novel explanations of traditional biological problems (such as natural finality, biological function, and the types of causation at work in living processes) in terms of the wondrous technologies of the baroque. Describing artifacts and bodies in the same terms, Cartesian mechanicism blurred the unity and boundaries of living bodies by integrating them into an immanent, monistic plane of matter that barred them from having any *substantial* principle of cohesion. Also life itself ceased to have any special ontological status; it became a mechanical illusion, something metaphysically indistinguishable from matter. I argue that such a shift was unique, and cannot be located in any other thinker preceding Descartes. Aristotle's biology predicated a number of principles that kept living organisms ontologically bound and whole, while his metaphysics prescribed criteria to differentiate artifacts and organisms (despite the possibility of drawing certain analogies between them.) Earlier forerunners of Cartesian mechanicism (such as Francis Bacon's writings on medicine and biology) do not even approach such a systematic and thorough collapse of the natural into the artificial, although works like *Nova Atlantis* (1624) clearly announce the biotechnological ambitions of modern science.[1]

There is a close alignment of heuristic and metaphysical aspects in Descartes's theory of life. That is, the fact that machine images are exploited for explanatory resources does not mean that these images should be considered as merely analogical strategies; their explanatory value is grounded on an explicit metaphysics that legitimates the uses of technological analogy, and on which physical explanations come to rest.[2]

I will begin with laying some basic groundwork in section 1. Through an examination of *Traité de la Lumiére*, I offer a brief exposition of Descartes's metaphysics and physics, which are often hard to tell apart. This leads us smoothly into Descartes's biology, as presented in the last half of the treatise. I stress the metaphysical immanence of matter that underlies the fusion of art and nature.

Section 2 moves on to examine how this affects certain traditional problems of biology, such as the definition of life. I argue that, in the context of Cartesian mechanicism, the problem presents itself as an epistemological one: how to distinguish living things from mechanical simulacra. Some posthumanist resonances of this theme are explored.

Section 3 analyzes how Descartes accounts for the unity of living bodies. I explain how this issue is closely tied to the problem of finality and the norms that should guide technological intervention on the living. Descartes's own philosophy of enhancement is explored through a reading of passages from his *Optics*.

Section 4 reconstructs one of the technocultural sources for the mechanical model. It argues that the machine is not just a heuristic devise but a metaphysical condition of possibility of representation. That is, the way it works as a model rests on the *a priori* acceptance of certain metaphysical assumptions about the nature of thought and perception.

Section 5 examines the question of philosophical anthropology. Where does Cartesian mechanicism leave the human? How are we to ground the relationship between humans and nature? How do we establish the bases for a project of control and modification, both of nature and the human itself *qua* natural organism?

The Conclusion argues for the importance of Descartes as the first architect of the posthuman shift. It proposes a schematic lineage of the body-as-machine thesis in the sciences of life, as well as the cultural repercussions of the banishment of 'life.'

1. A New World

The first work of Descartes's I will focus on is *Traité de l'homme*, an early treatise abandoned in 1632, and first published in Latin in 1662, twelve years after the philosopher's death.[3] This work (henceforth *L'homme*) is the first extensive attempt to rewrite life in exclusively mechanical terms. Here, Descartes develops the fascinating range of conceptual difficulties, experimental prospects and poetical possibilities opened up by the machine metaphor, setting "the parameters for much thinking about physiology in the eighteenth and nineteenth centuries" (Gaukroger 2002, 1) while remaining an outrageous proposal—a failure, even.

L'homme was intended as part of a monumental work, *Traité de la Lumiére* (*Treatise on Light*), abandoned in 1632 after Descartes learned of Galileo's conviction for promulgating the heliocentric thesis. This treatise expounded an ambitious system of natural philosophy by way of a no less ambitious cosmological fable in which the world is a vast artifice, God the supreme artisan, and living

beings are assemblages of mechanical parts. *Lumiére* was published posthumously in two parts: *Traité du Monde*, and *Traité de l'homme*. A third projected part on the human soul was most probably never written.

Both *Monde* and *L'homme* are part of the same narrative, a thought experiment about the creation of a hypothetical world. This artifice allows Descartes to present the entirety of his natural philosophy as a single narrative, a creation myth expressing the unity of science, traversing the stars, the solar system, meteorological phenomena, the movement of the tides, and the mechanisms of vision and living motion.

The basic principle of Descartes's physics is that matter acts by contact; that is, by collisions, pressures and displacements. Its foundation is the notion of a plenum, which satisfied an important requirement of mechanical explanation: that all movements are the result of the direct transmission of motion among bodies, without recourse to actions at a distance or occult, non-local influences. The only quality of matter is that it occupies space—in other words, *extension*. This leads Descartes to counterintuitive notions; for example: when a "vessel is full of gold or lead, . . . it contains no more matter than when we think it empty" (AT XI 21, G 15).[4]

Motion is the simplest mode of extension and serves to explain some of the fundamental properties of bodies. Solid matter is composed of particles at rest in relation to each other, while gaseous, liquid and other subtle forms of matter (such as fire) consist of subtler, rapidly moving particles. The planets, for example, are carried in their paths by eddies and whirlpools of supple fluid.

In addition to motion, physical properties are a function of the *size* and *shape* of particles. Both macroscopic and sub-visible phenomena behave essentially in the same way. One of the effects of the early modern abolition of the divide between sublunary and heavenly physics was the general principle that all matter everywhere follows the same principles of motion. Descartes took this move in the other direction, towards the infinitesimal. This was one of the main attractions of machine metaphors: they acted as macroscopic models of the busy micromachinery that composes animate and inanimate bodies.

The collective action of all this moving and colliding produces flows, or *tourbillons* of subtle matter; effects that it is tempting to call 'emergent,' provided we use the anachronism carefully. The important point is that the emphasis of Descartes's physics quickly shifts from hard bits of moving, differently shaped matter, to fluids and flows, which play a central explanatory role in the workings of animate bodies.[5]

Armed with these basic principles, Descartes then proceeds to assemble the world anew by way of a fable:

> But so as to make this long discourse less boring for you, I want to wrap up part of it in the guise of a fable, in the course of which I hope the truth will not fail to manifest itself sufficiently clear, and that this will be no less pleasing to you than if I were to set it forth wholly naked. [*Chapter 6 begins*]. For a while, then, allow your thought to wander beyond this world to view another, wholly new world, which I call forth in imaginary spaces before it. The Philosophers tell us that these spaces are infinite, and they should certainly be believed, since it is they themselves who invented them. But in order to keep this infinity from impeding and hampering us, let us not try to go all the way, but rather enter it only far enough to lose sight of all the creatures that God made five or six thousand years ago, and after stopping there in some definite place, let us suppose that God creates anew so much matter all around us that, in whatever direction our imagination may extend, it no longer perceives any place that is empty.
>
> Even though the sea is not infinite, those who are on a vessel in the middle of it can extend their view seemingly to infinity, and nevertheless there is still water beyond what they see. (AT XI 31–33, G 21–22)

Descartes presents us with this proposition: imagine that God made another world in a far region of space, an extension that stretches uniformly and indefinitely (but not infinitely) in all directions. This world is just like ours in every respect, populated with creatures who imitate our plants, animals and humans down to the last detail. This is a curious metaphor that must be taken literally, a universe both imaginary and real. This parallel world is the scaffolding that holds the entire exposition. For a start, it allows him to sidestep the heated disputes of the time and significant empirical considerations (like the impossibility of observing such very large and very small phenomena.) But it also consists in holding two different perspectives simultaneously. If God created a world anew by infusing motion in a block of inert substance, this world would be identical to ours; for, Descartes says, "God is immutable and . . . acting always in the same way, He always produces the same effect" (AT XI 43, G 28–29). As Bitbol-Hespériès shows, Descartes alternates between the expressions "real world" and "new world" throughout the text, employing them *exactly* the same number of times (Descartes 1996: xxxi).

This conceptual strategy has its cultural source in baroque anamorphic art and, more generally, in the period's obsession with visual trickery. Whereas classical representation creates closed and statically ordered spaces, baroque representation

is concerned with "complex, dynamic motion and multiple perspectives" in which the center of the representation "continually shifts, the result being the articulation of complex spatial conditions" (Ndalianis 2000). For Descartes, the automaton is not just a mechanical model, but also an optical framing device; it cannot be separated from a stage, a theatre of mechanical artifice.[6] A fascination with mechanized illusion is fundamental to Descartes's philosophy, traversing his epistemology, optics and biology. We will be exploring some of the implications of this.

At the beginning of *L'homme*, when the time comes to speak of the creation of humans, Descartes writes that the hypothetical men of his tale are composed of a body and a soul, and that each is to be treated separately. He continues:

> I suppose the body to be just a statue or machine made of earth, which God forms with the explicit intention of making it as much as possible as us. Thus He not only gives its exterior the colors and shapes of all the parts of our body, but also places inside it all the parts needed to make it walk, eat, breathe, and imitate all those functions we have which can be imagined to proceed from matter and to depend solely on the disposition of our organs.
>
> We see clocks, artificial fountains, mills, and other similar machines which, even though they are only made by man, have the power to move of their own accord in various ways. And, as I am supposing that this machine is made by God, I think you will agree that it is capable of a greater variety of movements than I could possibly imagine in it, and that it exhibits a greater ingenuity than I could possibly ascribe to it. (AT XI 120, G 99)

Descartes then offers an account of digestion, the formation and circulation of the blood, the actions of the heart, breathing, and other bodily processes, culminating in the brain and the mechanisms behind animal-human perception.

The acting forces in the body-machine are collisions, pressures, motions and the "fires without light" (AT XI 123, G 101) at the heart, which Descartes conceives of as a material reaction. Of the four Aristotelian causes, only the efficient one remains.[7] The animal spirits are matter in motion, containing no qualitative 'information' or agency.[8]

There are two main systems: the circulatory system of blood conveyed by the arteries (from the heart) and the veins (to the heart), and the motor-sensory system, consisting of hollow tubes packed with fibers and kept taut by the circulation of the 'animal spirits.' Perception and motor action share the same system of nerves, the tubes acting as conduits for the spirits that make possible muscular movement,

while the fibers convey the motions of sound, smell, taste, touch and vision from the sensory organs to the brain.

Arteries carry the blood in a straight line from the heart to the brain, where their size becomes small enough to let only the "most energetic, strongest and finest" parts of the blood to the brain (AT XI 128, G 104), following a simple mechanical principle in which the blood does not undergo any "preparation or alteration" (AT XI 130, G 106), but is separated into coarser and lighter parts by the heat of the heart. The heat makes the lighter particles travel more rapidly and become diffuse, becoming the 'animal spirits,' which Descartes describes as "a certain very fine wind, or rather a very lively and very pure flame" (AT XI 129, G 105). The arteries carrying the freshly reinvigorated blood divide into countless tiny branches and encircle the brain, then reassemble around the pineal gland (Descartes calls it 'gland H'), the seat of the mind, and the meeting point between the material body and the immortal soul. The subtlest particles of blood flow through "many little holes" into this gland. The pineal gland is a "very full-flowing spring" constantly emitting the spirits into the cavities of the brain, where they enter a multitude of conduits leading to the nerves (AT XI 130, G 106).

From the brain, these spirits then pass into the nerves and move the limbs. The nerve-tubes branch out to all the muscles, which the animal spirits inflate, occasioning movement:

> And the nerves of the machine that I'm describing can indeed be compared to the pipes in the mechanical parts of these fountains, its muscles and tendons to various other engines and springs which serve to work these mechanical parts, its animal spirits to the water that drives them, the heart with the source of the water, and the brain's cavities with the apertures. Moreover, respiration and similar actions which are normal and natural to this machine, and which depend on the flow of spirits, are like the movements of a clock or mill, which the normal flow of water can make continuous. External objects, which by their mere presence act on the organs of sense and thereby cause them to move in many different ways, depending on the arrangement of parts of the brain, are like strangers who on entering the grottoes of these fountains unwittingly cause the movements that take place before their eyes. For they cannot enter without stepping on certain tiles which are arranged in such a way that, for example, if they approach a Diana bathing they will cause her to hide in the reeds, and if they move forward to pursue her they will cause a Neptune to advance and threaten them with his trident; or if they go in another direction they will cause a sea monster to emerge and spew water in their faces; or other such things

> depending on the whim of the engineer who constructed them. And finally, when a rational soul is present in this machine it will have its principal seat in the brain and reside there like the fountaineer, who must be stationed at the tanks to which the fountain's pipes return if he wants to initiate, impede, or in some way alter their movements. (AT XI 130–132, G 107)

This passage makes an explicit reference to one of the technological sources of the metaphor: the mechanical garden theatres that had become fashionable with the nobles of renaissance Europe during the fifteenth and sixteenth centuries (and to which we will return in section 4). The movement of limbs and organs is the result of antagonist pairs of muscles connected through valves. The valves control the flow of the animal spirits into the muscles, so that when one muscle inflates, the other deflates, moving the limbs in opposite directions. Descartes explains through this principle the movement of the eyeball and eyelids, and the mechanisms of breathing and swallowing food. He then tells the reader that from these examples it is easy to understand all other actions like coughing, sneezing and yawning (AT XI 141, G 116).

As we can see, the reach of the mechanistic paradigm is vast. At the end of *L'homme*, Descartes invites the reader to consider all the functions he has ascribed to this machine:

> the digestion of food, the beating of the heart and the arteries, the nourishment and growth of the bodily parts, respiration, waking and sleeping, the reception of light, sounds, odors, smells, heat, and other such qualities by the external sense organs; the impression of the ideas of them in the organ of common sense and the imagination, the retention or imprint of these ideas in the memory; the internal movements of the appetites and the passions; and finally the external movements of all the bodily parts. (AT XI 202, G 169)

It is not until we enter the body that we experience the full poetic potential of technological metaphor. Descartes here deploys a riotous series of analytical elements: an array of mechanical parts (rods, bellows, valves, pulleys, tubes, levers, sieves, counter-weights and wheels), machines (organs, self-moving statues, fountains, clocks, mills), technical processes (distillation, sieving, impressions on cloths), and principles of work (water, air, weights, levers and balances, pressures and collisions) to assemble a see-through model that comes to stand for a virtual (neither lost nor real) flesh-and-blood original. *L'homme* is reminiscent of a long tradition of technological treatises dating back to the Alexandrian School, in which the subject of explanation is the structure of machines and the sequential action of their

mechanisms. What matters to Descartes is not this or that machine, but the laws of all machines, the very ontology of machines: an overarching *logos* that articulates these hitherto disparate technical elements together.

The passage from the physics of matter to the theory of life is seamless. The same principles apply to cosmic fluids and animal spirits; the same ontology of matter embraces both the animate and the inanimate, no further explanatory entities are necessary. We should emphasize that this tectonic shift affects not just the relations between physics and biology but also those between biology and technology. In other words, the living has become continuous with inanimate nature on one hand, and with machinery on the other. (As we'll see in section 5, this has important implications for philosophical anthropology and the ontology of the human.)

The convergence of automaton and organism should be seen as a special case of a much wider ontological reconfiguration: that of *art* and *nature*. An important outcome of Descartes's metaphysics is that the logical order of nature and art is inverted. Nature disappears altogether as a distinct, meaningful category, and becomes identical with matter: "Note, in the first place, that by 'nature' here I do not mean some goddess or any other sort of imaginary power. Rather, I am using this word to signify matter itself" (AT XI 37, CSM I 92).

Descartes's metaphysical physics admits only a difference of *degree* between natural and artificial automata. As we shall see, the difference is "not essential, but only modal" (Ablondi 1998: 79). Life is an effect of matter, an optical illusion modeled on mechanical simulacra.

In this manner, Descartes articulates one of the founding principles of the cybernetic approach to human-machine systems. In the introduction to a handbook for engineers, Sheridan and Ferrell state this principle in clear terms:

> Engineering systems can be made compatible with human characteristics and limitations only by means of quantitative analysis and experiment, and only when the behavior of both man and machine can be described in comparable terms. (Sheridan and Ferrell 1981: 3)

From one perspective, the shift is *asymmetrical*: technology is the primary epistemic field, the source of all explanatory resources. Part of Descartes's genius was to mine this field with an encyclopedic inquisitiveness, drawing from practically every area of technology available to him: technological treatises, automata displays, clocks, microscopes, optical tricks, fountains, the experimental setups of mechanics, etc.

Yet, there is a symmetrical relation also at work here, for Descartes admits artifacts as a natural kind. The machine can no longer be defined, like the ancients

did, as that which follows nature while remaining excluded from it. This requires that certain traditional problems and questions of biology be redefined in mechanical terms. What is 'life,' for Descartes? In fact, this question does not trouble Descartes as much as the question of *how* to tell apart a living being from a machine. In other words, it is an epistemological problem, rather than a strictly metaphysical one. This is the topic we turn to examine in the next section. This will lead us to the examination of other, closely related problems, such as the finality of living things and the normativity of nature. In turn, this has important implications for the relation between humans and nature, more explicitly for the norms guiding human intervention in nature and in our own bodies *qua* instruments.

2. The Uncertain Nature of Life

What is the difference between natural and artificial automata? And what are the ultimate consequences of the introduction of technological criteria in the philosophy of life?

Des Chene argues that Descartes "proposes to eliminate the living as a natural kind" (Des Chene 2001: 2). For Descartes, there is no *a priori* ground (soul, form) to establish how any arrangement of matter can be distinguished from a living thing. There are no souls of any kind animating matter, the human soul being purely rational and having no part whatsoever in the workings of the body. Descartes denies there is a "life-body dualism" (Mackenzie 1975: 4). Similarly, Hans Jonas notes that in Descartes's biology "the fact of life itself became unintelligible at the same time that the explanation of its bodily performance seemed to be assured" (Jonas 1970: 50). In *The Passions of the Soul,* Descartes defines life (not surprisingly by now) with reference to a machine:

> And let us recognize that the difference between the body of a living man and that of a dead man is just like the difference between, on the one hand, a watch or other automaton (that is, a self-moving machine) when it is wound up and contains in itself the corporeal principle of the movements for which it is designed, together with everything else required for its operation; and, on the other hand, the same watch or machine when it is broken and the principle of its movement ceases to be active. (AT XI 130–1, CSMX 219)

Descartes here specifies two criteria: an internal source of power (which is either 'wound-up,' or has ceased 'to be active') and an arrangement of parts (which is either in working order, or defective). Two analogies correspond to these criteria: a wound-up/wound-down watch and a watch in good repair/broken down. Thus the

definition of life is immediately deferred to a difference (between a living and a dead man), and this difference to an analogy (between two machines).

Although these criteria might help us tell between a living and a dead body, it does not allow for a distinction between animate and inanimate automata. To begin with, the existence of a source of motion is common to both. In animals and humans, Descartes locates this source in the 'fire in the heart,' which he suggests is also present in plants (Letter to Mersenne, 30 July 1640, AT III 122). This fire without light powers the circulation of material particles through the body; it is a source of heat mechanical in nature, a material process that Descartes defines in terms of machines. In *Description of the Human Body*, for example, the heat of the heart is described as "the great spring or principle responsible for all the movements occurring in the machine" (AT XI 226, CSM I 316).

The second criterion, the appropriate disposition of parts, also does not suffice to distinguish living from artificial. We could grant that the disposition of organs "is not a simple juxtaposition of independent elements, but rather a coordinated arrangement which defines the organism" (Rodis-Lewis 1978: 155). Yet this "coordinated arrangement" could easily define a machine also.

We could further restrict this to a *functional* definition of structure; that is, the fact that a structure is appropriate for a determinate set of functions, namely, nutrition, growth and generation or reproduction (Mackenzie 1975: 8). But it is feasible to imagine a machine designed to imitate these functions—which are, after all, mechanical in nature. In fact, this is what Descartes attempts in *L'homme*. A functional definition amounts to a normative description of living things; it doesn't tell us what life *is*.[9]

It is clear that none of the above is sufficiently conclusive. But Descartes offers two further, decisive conditions that aim to establish the difference between natural and artificial automata. Firstly, we have the size of components and skill of arrangement:

> I recognize no difference between artifacts and natural bodies, except that the operations of artifacts are carried out for the most part by means of components so large that they are easily apparent to the senses, for that is necessary so that they can be made by men. But natural effects, on the contrary, depend almost always on certain organs so small that they escape the senses. (*Principia*, AT VIII–1 326, CSMX 209)

> This will not seem at all strange to those who know how many kinds of automatons, or moving machines, the skill of man can construct with the use of very few parts, in comparison with the great multitude of bones, muscles, nerves, arteries, veins and all other parts that are in the body of any animal. For they will regard this body as a machine which, having been made by

> the hand of God, is incomparably better ordered than any machine that can be devised by man, and contains in itself movements more wonderful than those in any such machine. (*Discourse*, AT VI 55–6, CSMX 44)

This principle of 'extrapolation to indefinite complexity' crops up repeatedly in Descartes's writings, and can be defined as follows: the living automaton is a machine beyond the powers of human art because its components are of an infinitesimal size and their arrangement is exceptionally skilful. As Ablondi says, "Descartes believed such automata [i.e., 'natural' automata] could not in principle be produced *except by divine power*" (Ablondi 1998: 183).[10] The skill of God is simply human skill multiplied tenfold, and at some point this difference of degree becomes irreducible: a difference of *kind*. This distinction is further supported by a Christian vision of the universe, in which the prerogative of creation of the living is restricted to God. It is clear that Descartes never contemplates seriously the possibility of the manufacture of a truly living machine in this sense.

This criterion still does not change the fact that the distinction between art and nature has been severely weakened, for it is still a quantitative difference of sorts, not an absolute one. In principle, the laws of this godly mechanics are simple and within human grasp. For the early moderns, this was another attractive feature of technological metaphors: we can wholly understand what we construct ourselves.

This has some consequences for Descartes's conception of technology and the possibility of technological intervention on the living. On one hand, Descartes limits the scope of human knowledge and power; he argues that divine skill is *comprehensible* within certain limits, and that human knowledge has a truth that is sufficient for human purposes. On the other, the horizon of possibilities of technology is significantly expanded, reaching into the intimate workings of matter. Technology is admitted into natural philosophy, for it departs from a rational understanding of nature that hinges on the application of physical (that is, mechanical) principles in a methodical and efficacious way. In this sense, *L'homme* (and Descartes's project in general) did as much for physiology as it did for engineering, elaborating one of the earliest recognizably modern conceptions of technology.

So, the inviolable difference between the living and the made can be established in terms of a thing's history, its divine or human provenance; this ultimately determines its *nature*. The knowledge of the respective *species* to which a thing (natural or artificial) belongs gives us a certain, deductive standard with which to pass good judgment. This is significant inasmuch as the 'problem' of life is,

for Descartes, not metaphysical; he takes for granted that living things do not constitute a natural category.

The problem, however, is that a thing's nature cannot be straightforwardly deduced from its appearance; it is not directly available to the senses. Although Descartes considers a simulacrum capable of sustained deception unfeasible, the image of the deceptive machine appears repeatedly throughout his writings, as a figure that is absolutely but not *morally* impossible (that is, it is a speculative possibility that might never come to pass.)

The problem of picking out the mechanical impostor from its outward behavior remains a constant preoccupation for Descartes, leading him to device his own Turing (or Voigt-Kampff) test.[11] Although a convincing animal replica is feasible, Descartes does not take seriously the possibility of a perfect *human* replica, let alone that of a *thinking* machine. And yet the automaton is the central challenge of Cartesian epistemology, the paradigmatic case of spectacular trickery of the senses.

Nearly four centuries later, we find ourselves immersed in the historical reality of cyborgs, simulacra, mediated images, and quasi-intelligent machines. Unlike Descartes, we take the possibility of technological deception, supplantation, and the artificial instantiation of life and thought, very seriously. In fact, Hubert Dreyfus (2001) contends that the radical epistemological skepticism of early modernity is going through a kind of revival:

> [N]ow, at the close of the century, just as philosophers are coming to view the Cartesian subject/object ontology as mistaken and the epistemological problems it generated as pseudo-problems, new tele-technologies such as cellular phones, teleconferencing, telecommuting, home shopping, telerobotics, and Internet web cameras are resurrecting Descartes' epistemological doubts. . . . Indeed, skepticism is increasingly reasonable in the face of the growing variety of illusions and tele-experiences now available. (Dreyfus 2001: 54)

Posthuman culture manifests a contradictory mixture of fear and desire towards the uncertain boundaries of the body, mind, and the artifacts around us. Our age has invented colorful myths about disembodied minds, brains in jars, and intelligent computers. Although many of these things are yet to (or might never) come to pass, they hold great power not just as mythical possibilities, but as essential tools for self-reflection, central symbols of the age. In this context, Descartes should be acknowledged as the first to introduce the machine as an elemental mirror of the (post)human. In the words of Dalia Judovitz, the baroque automata of Descartes's

age already "adumbrate the anamorphic, virtual reality of a posthumanist world whose technological essence defines itself through impossible fictions, hypotheses of inhuman conceits" (Judovitz 2001: 96).

3. The Finality of Things, and How to Correct Nature

The question of technological intervention in nature passes through notions of finality and instrumentality. One of the most serious challenges for a mechanical theory of life was the reconceptualization of goal-oriented processes, one of the foundations of Aristotelian explanation. The conceptual universe of finality embraces notions of *design* and *function*, and leads to the problem of the normativity of nature, central to the bioethical debates of posthumanism. How can we take natural parameters (the 'normal' life-cycle, the 'natural' constitution of the human body, the principles of its individuality) as normative limits when these same parameters have ceased to have any ontological grounding?

Let's begin with the problem of biological function and design. Roughly, each organ has a function in the organism, and this implies a pre-existing design; in Aristotle's parlance, a *telos* or final cause. Before mechanistic biology, accounts of the formation of the fetus, the differentiation of organs and other related biological phenomena were heavily dependant on the idea that the seed of plants and animals already contained *in potentia* the fully developed organism. Medieval Christian natural philosophy had reworked Aristotle's fourfold schema of causation, making the natural ends synonymous with the 'intentions' of God. Descartes, on his part, insisted that Aristotelian teleology could not be accepted:

> This rule—that we must never argue from ends—should be carefully heeded. For . . . the knowledge of a thing's purpose never leads us to a knowledge of the thing itself; its nature remains just as obscure to us. Indeed, this constant practice of arguing from ends is Aristotle's greatest fault. (Descartes 1976: 19)

Descartes also articulated this demand in theological terms. If God is perfect and inscrutable, then we cannot refer to final causes in our science, for it would amount to knowing God's purposes:

> The arguments you adduce on behalf of final causality are to be referred to the efficient cause; thus it is open to us, from beholding the uses of the various parts in plants and animals to regard with admiration the God who brings these into existence, and from a survey of His works to learn to know and glorify the author of these works, but that does not imply that we can divine the purpose for which He made each thing. And although in Ethics,

> where it is often allowable to employ conjecture, it is at times pious to consider the end which we may conjecture God set before Himself in ruling the universe, certainly in Physics, where everything should rest upon the securest arguments, it is futile to do so. We cannot pretend that certain of God's purposes rather than others are openly displayed; all seems to be equally hidden in the abyss of His inscrutable wisdom. (Descartes 1991: 215)

The problem of finality has a number of dimensions. To begin with, a mechanistic account had to provide an account of the generation of *individuals* (epigenesis) and of *kinds* (phylogenesis) (Des Chene 2001: 10–11). The latter was a less immediate problem, for the prevailing belief in the seventeenth century was that God had created all life-forms in their present shape. A strictly mechanical account of epigenetic development presented more serious challenges.[12] *L'homme* starts off with a ready-made automaton, a ruse that allows Descartes to sidestep some of these difficulties. The notion of a predetermined design, however, permeates functional explanations as applied to the fully developed organism. Throughout *L'homme* we can find casually strewn references to this divine plan; for example:

> As for the disposition of the tiny fibers that make up the substance of the brain, it is either acquired or natural; and since what is acquired depends upon all the various circumstances that change the course of the spirits, I shall be able to explain them better later. But in order to show you in what the natural ones consist, consider that, in forming them, *God so disposed these tiny fibers that the passages He left* between them are able to conduct the spirits, when these are moved by a particular action, toward nerves which allow in this machine just those movements that a similar action could incite in us when we follow our natural instincts. (AT XI 192, G 163; emphasis added)

So, Descartes's biological explanations admitted some form of divine intentionality, visible in the function of the finished organs. Intelligent design, in fact, was an important feature of the machine metaphor, and one that modern science had some trouble putting to rest.[13] One of the advantages of the mechanistic thesis was precisely this engineering approach to the organism, which permits a detailed understanding of function: the mechanisms by which each part in the organism carries out its predetermined end.

Now, if we are ready to accept this, at least momentarily, we still face another problem when we turn to the organism as a *whole*. What is the function of an organ-

ism? If functions dictate the *principle of unity* of each organ (the reason why an organ has structural closure), then what is the principle of unity of the body as a whole?

The question of bodily unity and boundaries is first found in Descartes's very definition of a body. Descartes equates matter with space itself; its only quality is the place it occupies. The banishment of souls and final causes is closely followed by that of forms, the ideal principle of unity in the dominant natural-philosophical tradition up to Descartes. What is a 'body,' for Descartes? Can we draw boundaries around it? Can we establish some criteria by which, say, a chair, a vortex, a cloud of gas, or a dog, is considered a separate body? Descartes's answer is quite clear: the only criterion of bodily cohesion in Cartesian physics is the degree of common motion of particles. Thus, a piece of wood is composed of particles of a certain shape which stand in relative rest in relation to each other, and so on.

The machine offers a strong heuristic framework with which to analyze and represent structure and function, as well as an attractive program of experimental meddling and observation. But this comes at a high cost: an explanatory focus on elementary parts and microscopic structures transforms the organism into an agglomeration of mechanisms, a fragmentary assemblage with no clear unity. Thus, the unity of the living body in Cartesian science is purely contingent; there is no internal, substantial or *a priori* principle that guarantees it. In his examination of this issue, Des Chene distinguishes four principles of unity in Descartes's mechanical physiology: *physical*, *dispositional*, *functional* or *intentional*, and *substantial*. This last type of unity is proper only to the body-soul. Des Chene argues that Descartes accounts for all of the above in some manner; but ultimately "the only real, the only metaphysical reason to call the body *one thing* is that God has willed that this collection of parts of matter should be our instrument" (Des Chene 2001: 152). That is, intentional or functional unity is the only one that holds. Unity is a result of the interrelation of organs, the function of which is to ensure the continuing, healthy working of the body:

> For the body is a unity which is in a sense indivisible because of the arrangement of its organs, these being so related to one another that the removal of any one of them renders the whole body defective. (*The Passions of the Soul* [AT XI 351, CSM I 339])

Des Chene also argues that the problem of boundaries has a disciplinary dimension. For Descartes "there seems to be no principled way to make the required distinctions among the objects and events of one science and those of another, and thus no way to keep physiology from expanding until it becomes a science

of everything" (Des Chene 2001: 62). This is a logical outcome of the immanent character of Descartes's universal mechanics. In a similar note, Emily Grosholz criticizes Descartes's explanatory strategies for their 'flatness.' Grosholz (1991) argues that Descartes's

> methodological penchant for conceiving the enlargement of scientific knowledge as the construction of new complexes from homogeneous terms associated by a single, transparent relational structure . . . leads him to regard his biological work as a straightforward extension of his physical principles to new areas of research. . . . In other words, he cannot recognize methodologically the extent to which he is negotiating heterogeneous levels of description . . . and not a homogeneous field of facts about matter in motion. (Grosholz 1991: 127)

This is true; yet this immanence of mechanical explanation (reflecting the ontological immanence of the machine *qua* metaphysical thesis) establishes deep continuities between bodies of knowledge; in particular, physics, biology and technology. Cartesian body-machines are malleable and open to the world. They are shaped by history and technology. In the words of Alan Snider, "the mechanistic banishment of mind from nature could have the effect of blending animate and inanimate, active and passive, creating a sort of affinity and even fellowship between ourselves and the world" (Snider 2000: 303). John Sutton describes the Cartesian body-automaton as a porous, unfixed entity, written by history and open to outside flows. For Descartes, "no body is unconnected or unconstrained" (Sutton 1998: 88), for the animal spirits

> connect the deepest interior, the pineal gland, to the world in numerous ways. It is not just that muscular motion requires appropriate spiritous input from brain to periphery. Rather, interior and world are always already connected, for the state of the body at a time results from the history of its interactions. (Sutton 1998: 56)

Sutton argues that Descartes's brand of mechanicism articulated a novel way to understand how habit, history and memory shape living matter: a body that is receptive, dynamic and fully posthuman.

If the only natural norm of the body is the mutual interrelation of the organs, we can easily envision the replacement of certain elements of this arrangement without affecting the 'nature' of the whole. We could replace organs or limbs with artificial ones, add a pacemaker or a life-support machine, thereby allowing the

body to sustain its normal functions. As long as functional integrity is maintained, these prostheses are to be considered parts of the body, equivalent in all respects to the originals. The only limit is practical.

So far, this concerns merely the repair and maintenance of organs. What about the possibility of *augmentation* of functions? On this, the mechanistic view also seems to offer a firm theoretical foundation.

Descartes, as is well known, was particularly interested in the prospect of extending life and repairing the body. The most extensive treatment of these issues can be found in his *Optics*. Here, Descartes makes a distinction between the aims of medicine and that of optics. Medicine, he says, remedies the deficiencies of the body through the "correction of natural organs," while optics ministers "to the same deficiencies through the application of other organs that are artificial" (AT VI 164–65; Descartes 1965: 126). We might wonder, considering all the preceding, how this distinction between natural and artificial can be sustained. Doesn't the correction of a natural organ already assume artificial intervention? Moreover, Descartes's optics is characterized by a smooth theoretical continuity between physiology and instrument-making, which is fundamental to his program for the augmentation of vision through the means of lenses, microscopes and telescopes.

Also, Descartes's account of vision is nourished by technological concerns. A series of diagrams from the *Optics* (Figure 2) presents different illusionistic effects obtained with lenses, prisms, and concave and convex mirrors. The diagrams clearly sum up how Descartes's fascination with illusionism and curious optical effects lies at the heart of his theory of visual perception, so that 'normal' or natural perception is conceptualized through artifactual distortion and illusion—a conceptual twist whereby technical trickery becomes the origin of a theory of 'natural' perception. It is also this hinging of perception on illusion that allows Descartes to conceptualize the augmentation of vision through these same devices.

This functional and ontological equivalence of eye and instrument (a subset of the larger merging of body and machine) is dramatized in an experiment Descartes describes at the beginning of the Fifth Discourse of the *Optics* (see Figure 1). Early modern optics conceived the elements of the eye in terms of a point-by-point analogy with the *camera obscura*. Repeating an experiment already performed by others, Descartes puts the analogy into action:

> But you will be even more certain of this if, taking the eye of a newly deceased man, or, for want of that, of an ox or some other large animal, you carefully cut through to the back the three membranes which enclose it, in such a man-

> ner that a large part of the humor *M* which is there remains exposed without any of it spilling out because of this. (AT VI 115; Descartes 1965: 91)

Descartes then covers this hole with a paper, eggshell or "some white body thin enough to let the daylight pass through," and places it in the hole of a sealed chamber ("where you will be"), so that the eye is looking out at the scenery. We can see, then, "not perhaps without admiration and pleasure" a small inverted image on the white cover that "will represent in natural perspective (*fort naivement en perspective*)" the view outside the chamber (AT VI 115; Descartes 1965: 93). In this performance, the metaphor has become literal. By assembling a machine out of inanimate and animate parts, he shows us their perfect continuity of form and function.

This joining of artifact and organ mobilizes, in turn, a multifaceted play between art and nature. Descartes begins the Seventh Discourse of the *Optics* ('On the Means of Perfecting Vision') by saying that, now that the way vision operates has been examined, the next step is to recapitulate "all the conditions that are required for its perfection" so that "we can make an exact enumeration of all that still remains for art to add to it (*toutes les conditions qui sont requises à sa perfection . . . nous puissions faire un dénombrement exact de tout ce qui reste encore à l'art à y ajouter*)" (AT VI 147; Descartes 1965: 114). He reduces the mechanism of vision to three elements: the objects, the internal organs that receive the motions from these objects, and the external organs that mediate between the two. Concerning the interior organs, Descartes says, "it is . . . certain that we could not add anything to their fabric through art (*nous ne saurions rien ajouter part art à leur fabrique*); for we could not make a new body, and if the doctors can help here in some way, this does not belong to our subject" (AT VI 148; Descartes 1965: 114). Thus, only the external organs can be enhanced, or 'added to,' through art. As we know, biomedical advances in the last century, especially, have made possible the restoration and enhancement of the functions of internal organs as well. Pacemakers and hip replacements are two well-known examples of this.

The agency of nature is that of a conscientious, active engineer: "Nature has employed several means to provide [*la Nature a employé plusieurs moyens a pourvoir*]" (AT VI 149): "we must assume that Nature has done, in this regard all that is possible" (AT VI 149); "by the black color with which she has dyed all nontransparent parts of the eye opposite to the nerve, she has prevented another ray from going to these same points" (AT VI 150); and so on. Rather than the ensouled instruments of Aristotelian biology, nature's role here is that of a designer who does not directly control or tinker with the activity of 'her' machines, but provides

an autonomous, versatile device that anticipates all eventualities that might arise during functioning.

Then, Descartes changes his tone. Nature has designed the eye so that it can change shape and adjust to the rays coming from objects at different distances. "Nevertheless, she has not so completely provided for this last part that something cannot still be found to add to it." The problem is that we cannot clearly see objects that are very near, an inch or half an inch from the eye. As the body gets older, the eye hardens, and can only perceive "things that are far away," while the young tend to have the opposite problem. This is not merely an oversight, Descartes says, but a *failure*. Nature has "failed" or "lacked more seriously (*elle y a encore manqué*)" (AT VI 150) in these cases:

> Thus, in order for us to remedy these deficiencies through art (*remédier par art à ces défauts*), it will first be necessary that we seek what shapes the surfaces of a piece of glass or of some other transparent body must have, in order to curve the rays falling on them in such a manner that all those rays from a certain point of the object are disposed . . . as if they had come from another point, which was nearer or farther away. . . . To aid those . . . who wish to see objects nearer that the shape of their eyes will permit. (AT VI 150–1; Descartes 1965: 116–17)

These deficiencies are not so much flaws of design as unforeseen lacks or limitations. But the two are hard to distinguish. According to Descartes, our task is to approach the body as an engineer would approach the redesign of a machine. Descartes conceives of vision as a technical system that can be abstracted from its embodied apparatus and the context of its natural ends. The process of optical focusing can be considered technically, in terms of a spectrum: from the near to the far. Nature has only provided us with means of accessing a small portion of this spectrum, but at the two extremes we find the microscopic and the astronomically distant, the two realms that the science of optical instruments permits us to access. Thus, Descartes becomes like an engineer evaluating the work of another engineer and making amendments to it, while advocating the respect of some pre-established norms: "we will always have to take care, when we thus place some body before our eyes, that we imitate Nature as much as possible, in all the things that we see she has observed in constructing them; and that we lose none of the advantages that she has given us, unless it be to gain another more important one" (AT VI 152; Descartes 1965: 117). Nature sets some normative guidelines that allow us to overcome nature in the quest for achieving human ends. The problem,

then, is *metanormative*: which norms are we to apply to the suspension of natural norms? The conflict here is between nature as normative and the norms that an engineer might bring to bear on the problem of designing an artifact for a particular end. Descartes suggests that the engineer is allowed to consider the function of the organ decontextualized from the ends for which it was naturally constituted. The *organon* becomes instrument in the technical sense, serving human rather than natural ends. Again, the nature-as-machine thesis provides the metaphysical framework that makes such a project possible.

The kinds of difficulties that arise from this are now too familiar to us. Take the analogy of legs. If the function of these organs is locomotion, then we could consider mobility as an abstract spectrum subject to technical norms and improvement. It follows that running faster and quicker might be considered a worthwhile correction or improvement on nature. The fact that this end might be achieved with an automobile or a plane would be irrelevant in terms of the organ's function: ontologically speaking, if we are to follow Descartes to the end, such motor prosthetics should be considered as part of the human makeup. However, we posthumans are also aware that prostheses have their own dynamics. Rocks are not merely extensions of the hand's capacity to strike: they open an entirely new field of possibilities, radically reconfiguring the relations between humans and their environment. Thus technologies are often disrespectful of human desires and ends, and introduce deviations to the courses of human agency and control. This is not the place to elaborate a theory of prosthesis; my aim was merely to show how these problems already arise at the classical heart of mechanicism, following inevitably from the moment living things are understood in technological terms.

4. The Automaton as Representation

As I have argued, the automaton's function as a heuristic strategy and a metaphysical thesis are hard to disentangle. In this section, I want to show how its metaphysical status must precede and ground its acceptance as a theoretical model. In *L'homme*, the automaton is a *framing device* that creates a virtual perceptual field through which to view the body. *L'homme* not only presents a theory of mechanical life but also *represents* and *performs* it. In this manner, the automaton is not just a hypothetical model, but the condition of possibility of representation, that is, of all models.

Here, I will be approaching Descartes's natural philosophy from a posthuman perspective, arguing that certain artifacts found in a cultural context are active participants in the production of knowledge. Knowledge, in this view, is not the product of a disembodied and ahistorical human mind, but the result of a complex

material "mangle."[14] It is the collective production of located bodies, artefacts, discourses, and embodiment relations that extend into the technological environment.

In *L'homme*, Descartes carries out a practical rehearsal of the instrumentalization of perception that the technologies of the baroque already portend. The reader is asked to *embody* an enhanced form of vision in which the eye is instrumentalized as a technical device. For Descartes, cognition has a fundamental material basis, which means that the corporeal mind *extends* into the environment. In turn, this allows Descartes to transpose phenomenological schemas drawn from certain forms of technology. These phenomenological structures are neither conceptual nor material, and Descartes's own theory of perception allows us to account for how this passage between the conceptual and material takes place.

We will look at just one of these technologies, tracing the technocultural genesis of the conceptual and rhetorical space that performs this intricate exchange of properties between nature and technology. We will begin by examining how certain spatial and phenomenological features of baroque spectacular automata come to structure the conceptual and heuristic apparatus of *L'homme*'s ideal machine.

The gardens that Descartes mentions in the quote above (section 1) consisted of an arrangement of terraces and grottoes where the spectator could wander at leisure (see Figures 3 and 4). They featured singing mechanical birds, moving statuary, automated organs, trumpets, ornate water fountains, and mythological scenes enacted by self-moving figures. One of the most lavish and accomplished creations in this vein was the Royal Château of Saint-German-en-Laye, designed by Tommaso and Alessandro Francini, and which Descartes most likely visited between the summer of 1614 and the autumn of 1615. (The description in *L'homme* is consistent with the grotto of Orpheus.) A contemporary visitor to St.-German recorded the scenes in these grottoes:

> There is a nymph standing in half-relief with a laughing face, beautiful and gracious, who allowing her fingers to be moved by the movement of the water, plays on an organ. Near the window is a statue of Mercury with one foot in the air and the other placed on a support, noisily sounding and intoning a trumpet. The cuckoo is heard and recognized by his song. On the way out . . . a fierce dragon is encountered who beats his wings with great vehemence, and violently belches forth huge mouthfuls of water. The dragon is accompanied by various little birds, which truly seem not painted or imitated but alive, fluttering their wings, making the air echo with a thousand warblings, and above all, the nightingales singing very beautifully in several choirs. (Chapuis and Droz 1958: 44)

Another contemporary, after praising the skill of the mechanician, expressed his contempt at the bad taste of "this gim-crack ironmongery" (Chapuis and Droz 1958: 47). Kenneth Knoespel argues that these machines drew attention to their own artificiality, directing wonder at the power of human art: "As the observer moved through the new renaissance gardens, he simultaneously undertook an allegorical journey based on established mythographic stories and encountered an array of new technological devices that challenged him to a new awareness of technology" (Knoespel 1992: 112). In technical terms, "[l]ittle change and no improvement had taken place in these mechanisms since the time of Hero" (Chapuis & Droz 1958, 41). The main motive forces of these automata were weights, water and simple pneumatic principles; these forces then were conveyed by pulleys, ropes, gears, water wheels, reservoirs and pipelines.

Significantly, the conceptual space of *L'homme* shows a range of close homologies to this technological form. The most obvious parallel is that both are conceived as instructive spectacles, harnessing the spectacular dimension of technology for pedagogical and moral purposes. The mechanisms described in *L'homme* act as a kind of supplementary moment to the wonder experienced in these gardens, for here Descartes unveils the machine and takes the reader on a behind-the-scenes tour of the various physical reactions that make the automata move, thus dispelling one kind of wonder to create wonder of another kind: a wonder at the technological sublime. Thus, from an artificial, superficial and confused wonder, we move into a philosophical wonder.

This space is structured along three main polarities: inside/outside, appearance/reality, and subject/object. In *L'homme*, the ambulant spectator in the paths and grottoes is transformed into a non-located, omniscient observer. Thus, the embodiment relations present in this technological spectacle constitute one of the structuring forces behind a model of knowledge that seeks to erase bodily location in a quest to build a disembodied and omniscient system of representation. As we follow Descartes in his virtual tour, the movements follow a specific spatial structure, organized across two axes: a syntagmatic (up-down) line following nerves and spirits through the body, and 'micro-macro' (paradigmatic) switches between the visible and the infinitesimal (what we would now call 'zooming in and out.') This vision machine is an amalgam of technical devices, incorporating also the imaginary space of early modern microscopy, and the methods of representation characteristic of the technological and medical treatises of the period; these were also key technocultural sources that won't be examined here for reasons of space.[15]

Conceptually, *L'homme* creates a strange apparatus of representation: an eye without a body (a technologically enhanced vision born of the science-fictional marriage of microscopy and mechanical simulacra) travels through the insides of a body that has also been virtualized into a technical diagram. Bodily insides have been exteriorized into a series of blown-up images containing no sense of location and scale, as depth is flattened on a diagrammatic plane. The illustrations in the French edition of *L'homme* (which better capture the spirit of Descartes's methods) are an original synthesis of anatomical illustration, geometrical diagramming, and technological representation. Although these aspects will not be examined here, it is important to establish that *L'homme*'s representational apparatus springs from a rich poetic synthesis of a range of material and phenomenological sources. We should think of this apparatus in terms of embodied and material cognition; that is, it draws resources from bodily, located modes of knowledge, as well as external schema found in specific technologies. Although the treatise attempts to construct a disembodied consciousness transcending its material and bodily conditions, this consciousness can equally be reconstructed as an emergent product of these conditions, which are constitutive elements in the production of scientific knowledge (at least in this case.)

Following Catherine Waldby's observations, *L'homme* can be said to reveal an important dimension of the biomedical imaginary, which she defines as "the speculative, propositional fabric of medical thought, the generally disavowed dream work performed by biomedical theory and innovation" (Waldby 2000: 136). Like much of current biomedical imaging and biotechnological intervention, Descartes also "address[es] and incite[s] organisms as themselves technics" (Waldby 2000: 39), raising the fundamental posthuman question of the "defining limit or distinct interface between organs and technics" (Waldby 2000: 40).

This defining limit is very much erased in Descartes's theory of perception. Let's examine how this takes place.

Descartes's account of vision is partly geometrical and partly mechanical. Rays of light are rectilinear tendencies to motion transmitted through the plenum and reaching the eye, where they are refracted and refocused into points of pressure that trace patterns on the retina at the back of it. Lines and figures are applied to the modeling of physical effects. As Nancy Maull says, for Descartes "the only intelligible and true information to be had about bodies is geometrical" (Maull 1978: 27). At the moment the pressures at the back of the eye are communicated to the brain through the tubes in there, we leave the language of images (an optic-geometric paradigm) to enter mechanical explanation proper (i.e., pneumatics and

mechanics.) In the cavernous industry of the brain, there are a vast number of filaments in the optic nerves corresponding to each point of the image (see Figure 5); different patterns of pressure pull different fibers, enlarging the openings in the brain and thus forming different figures inside it. So, Descartes's system of perception can be pictured as a flow of patterned emissions: from object, to plenum, to common sense, to imagination. These patterns do not 'resemble' each other, but are nevertheless, in the words of Peter Galison, *congruent* (Galison 1984: 320). (Dennis Sepper calls them 'proportional' [Sepper 1996: 320]; the two terms are equivalent.)

Jean-Pierre Séris likens this perceptual mechanism to an information machine, comparing it to the workings of a punched card computer (Séris apologises for the anachronism), since the 'processing centre' of the brain responds to incoming patterns of open holes and allows the 'output' of spirits. Séris argues that the principle of this machine is "the instantaneous communication of differences at a distance, by encodings and automatic translations which save or preserve diversity . . . [and] the decoding of the world of physical phenomena according to a grid or alphabet or a sieve which restores its effects" (Séris 1993: 183). However, the metaphor of an information machine undervalues the busy, visceral embodiment of cognitive processes. The patterns on the inner walls of the brain are shifting diagrams of pressures and flows, openings and closings, pushing and pulling motions. They are explained in markedly physical terms and using predominantly tactile metaphors: vision is a special case of touch. The points have dimensions, and Descartes even confers explanatory power to the *degree* of their openness. This is an 'analog' machine, not a digital one—inasmuch as it does not work on the basis of 'on/off' circuits, zeros and ones, but the holes and pressures allow for indefinite degrees of variation (like a hand-operated dial, if you wish).

In the brain, figures flicker at amazing speeds and are temporarily stored, recombined into composites, and then assembled into the building blocks of corporeal ideas. This activity can be pictured only schematically, through simple geometrical figures that stand in for the literally unimaginable activity of nature. Reason can be relied upon to grasp this activity only through the material representations that become accessible to it through the language of elementary (intellectual) ideas. Most importantly, though, Descartes's theory implies a strong continuity between 'external' technical diagrams and those composed in the corporeal imagination; both are material, congruent forms of representation.

Thus, the process of rational understanding is inseparable from the work of the corporeal imagination; the fountaineer must constantly negotiate with it. But it

is difficult to establish any 'natural' barrier between ideation and technical representation; in this way, the Cartesian corporeal mind extends into the environment, as internal and external representations are placed in a continuum in permanent flux. As we shall see, the stage of the brain is the central locus of the struggle to control nature, as it is the place where the human will must directly impinge on the flows of matter that make the machine of the body move.

5. The Human, this Homeless Instrument

Let us return to this question, then: If organs and organisms are not just machines but *instruments,* which (or whose) ends do they serve? Can these ends serve as norms that can be applied in the manipulation or redesign of 'nature'?

Hans Jonas argues that, in Descartes's theory of life, the body's "performance, however devoid of immanent teleology, must serve an end, and that must be someone's end" (Jonas 1970: 50). If humans are the sole possessors of ends, then all other life is "the product of physical necessity, [and] can be considered his means" (Jonas 1970: 51). Many commentators have read Cartesianism as legitimating the unrestrained possession and mastery of nature, both animate and inanimate, that marks the modern scientific outlook. Georges Canguilhem writes:

> The theoretical mechanization of life is inseparable from the technological utilization of the animal. Man can claim possession of and mastery over nature only by denying that nature has any purpose in itself, and then only by regarding all of nature other than himself—even that which appears to be animate—as a means to an end. (Canguilhem 1994: 227)

From this perspective, Descartes's philosophy can be accused of an "anthropocentric vanity" (Jonas 1970: 52) and can be read (as it has been many times) as a seminal expression of the modern technological worldview. Thus the issues of instrumentality and finality reach outside biology to pose some difficult philosophical and moral concerns.

Descartes's vision for the sciences is technological in another sense: not just in terms of mastery, but in the sense that science itself is instrumental, since its ultimate purpose is utility and material efficaciousness. As Peter Schouls says, the "abstract thinking required for pure science is, for Descartes, never to be an end in itself" (Schouls 2000: 128). This thinking "has instrumental value only, [in] that it serves to lay the foundations for mastery" (Schouls 2000: 128). Thus we must move "from abstract thought to useful, practical knowledge as soon as this is

legitimate, that is, as soon as abstract thought is sufficiently advanced to serve as proper foundation" (Schouls 2000: 129).

Descartes places his technological project in a moral context. Of all the fields of natural philosophy, medicine is the area where Descartes's technological bent is most explicitly articulated. Medicine is a technological activity with moral ends—three main aims, in fact: the understanding and banishment of disease, the prolongation of life ("freeing us from innumerable diseases and perhaps even from the infirmity of old age" [*Discourse*, AT VI 62; CSM I 143]), and the restoration of organs to their healthy state. Descartes's conception of medicine is not a radical departure from tradition, and its interventionist and activist character continues the practices of earlier times. Descartes regards medical knowledge as part of a project of moral improvement, guided by the Delphic maxim, 'know thyself.' The beginning of the *Description of the Human Body* expresses this clearly:

> There is no more fruitful exercise than attempting to know ourselves. The benefits we may expect from such knowledge not only relate to ethics, as many would initially suppose, but also have a special importance for medicine. I believe that we would have been able to find many very reliable rules, both for curing illness and for preventing it, and even for slowing down the ageing process, if only we had spent enough effort on getting to know the nature of our body, instead of attributing to the soul functions which depend solely on the body and on the disposition of the organs. (AT XI 223–4; CSM I 314)

The mastery of nature requires that we approach it (in this case, the human body) as a mechanical system open to rational understanding, representation and tinkering. In this respect, Descartes's technological project has a deeply humanistic character, as it rests on the assumption of human freedom and the existence of a free will. In the words of Schouls, the exercise of science "requires acts of will, that is, presupposes that human beings are essentially free. Human essence must therefore be taken as distinct from that of mechanistic nature" (Schouls 2000: 27).

Descartes's program for the development of a practical philosophy, as Gary Steiner argues, must be understood "in terms of the relationship between divine, natural and human law proposed by Aquinas in the *Summa Theologica*" (Steiner 2004: 110). The law of reason is not enough to commit us to improve the lot of humanity. Human moral law is derived from divine law. Both Cartesian and Christian metaphysics share a commitment to the view that "the realm of nature is of a lower order of existence than the human soul and that the value of nature consists

primarily if not exclusively in its contribution to human material welfare" (Steiner 2004: 110). In this respect, Descartes's philosophy can be placed in the tradition of Aquinas and St. Augustine—while departing from Augustinian ideals because of the autonomy he prescribes to human reason.

Nonetheless, Descartes's view of science has a strong anti-anthropocentric bent, inasmuch as it regards human knowledge as founded on the inscrutability of divine designs. The purpose of creation is not man, but God:

> We would be overestimating ourselves still more if we were to imagine that God created all things solely for us, or if we were to consider our intellect powerful enough to understand His ends in creating the universe. . . . For although, from a moral point of view, it may be a [good and] pious thought to believe that God created all things for us, since this may move us all the more to love Him and to give thanks to Him for so many blessings; and it is true in a sense, since there is no created things which we cannot put to some use, even if it is only a matter of exercising our minds by contemplating it and, by means of it, being moved to praise God: it is, however, in no way likely that all things were made for us in the sense that God had no other purpose in creating them. And [it seems to me that] it would be clearly ridiculous to attempt to use such an opinion to support reasonings about Physics; for we cannot doubt that there are many things which are currently in the world, or which were formally here and have already ceased entirely to exist, which no man has ever known or used. (Descartes 1983: 182–83)

Nature is not here solely for our ends, although it is hard to derive from the above any clear guidelines as to the limits and norms of technological exploitation and intervention. Even granting that such a coherent framework is possible, there remains another, more fundamental problem: even within this circumscribed realm of action, the dominance of reason over matter is far from assured by the mechanical picture. There is a troubling tension here between the autonomy of reason and the vast reach of mechanistic nature, which halts only at the surface of a small gland at the center of the brain.

Although later, in *The Passions of the Soul*, Descartes asserts that the soul "is really joined to the whole body, and that we cannot properly say that it exists in any one part of the body to the exclusion of the others" (AT XI:351, CSM I:339) he continues to maintain that there is

> nevertheless . . . a certain part of the body where it exercises its functions more particularly than in all the others. . . . [This is] the innermost part of the brain, which is a certain very small gland situated in the middle of

> the brain's substance and suspended above the passage through which the spirits in the brain's anterior cavities communicate with those in its posterior cavities. The slightest movements on the part of this gland may alter very greatly the course of these spirits, and conversely any change, however slight, taking place in the course of the spirits may do much to change the movements of the gland. (AT XI:351, CSM I:340)[16]

Marooned in the midst of a virtually infinite ocean of matter, the immaterial thinking substance is restricted in its capacity to impose its own signature over its environment. It has no vital role, only an uncertain causal role in directing the motion of the animal spirits as links in the chain of perception-action. The relation between soul and body can thus be posed as a technological one: a problem of instrumentality and control. The question of technological power over matter is dramatized on the stage of the body-automaton, 'our' closest instrument. It is popularly believed that Descartes advances a model of the mind based on the sovereignty of consciousness, what Margaret Wilson calls "the doctrine of epistemological transparency of thought or mind " (quoted in Cottingham 1996: 211fn); yet Descartes also formulates his own version of the unconscious, a domain of reflex actions and involuntary decisions that take place without any intervention of the mind. According to Cottingham, Descartes "offers a strikingly original insight: *the causal genesis and subsequent occurrence of the passions is intimately linked to corporeal events in ways which often make the force of the resultant emotion opaque to reason*" (Cottingham 1996: 210). Opaqueness to reason (at least in the sense of self-transparency) is a logical result of the embodied nature of the human, in which 'programmed' responses (the product of nature or individual history) are stored at a physiological level below awareness. The machine is, then, the unconscious of the body. *The Passions* is the closest Descartes came to writing a user's manual of self control. Here the management of the self is redefined in terms of mastery over the body-machine, which is the starting point of the exposition. This late work is concerned with what Guido Giglioni calls the "*passionate automaton*," the "human psycho-physical compound, where the intervention of the soul makes it a kind of anomalous substance in the universe" (Giglioni 1997:155). But a totalizing representation of this machine seems to frustrate our most concerted efforts of the imagination. With the body-automaton thesis, Descartes gestures towards the mathematization of physiology: the measurement, visualization and quantification of the body. Yet this fluid and busy assemblage of micro-biomachinery, by its very nature, escapes representation; the best we can do is create diagrams that assure certain manipulability. The success of our representations is

measured by their technological efficaciousness, rather than by how completely and successfully they fit reality.

Turning now to the larger problem of reengineering nature, the prospect of mastery also looks uncertain. Embedded in a mechanized world, the soul can only impose on nature through schemas of representation and action; that is, through technological means. Yet these representations can only consist in technical shortcuts, forms sufficient for the human intellect. Moreover, they are material forms, flickering through the walls of the imagination and stored in the physical memory of the automaton; as such they are subject to the laws of mechanical generation and reproduction. To intervene in the execution of the most minute movement or thought, the thinking substance must mobilize this machine by activating its innermost fulcrum, the vanishing causal point that constitutes the center of reason.

The problem does not stop with the *means* of mastery, but extends to the question of the *ends* of this endeavor. What are the ends of the human? Are there any normative boundaries guiding the technological project, or are we free to remake ourselves at will? As we have seen, Descartes's philosophy complicates the task of positing nature as a normative benchmark. The machine metaphor suggests a functional definition of the human body that reconfigures it as an instrument without clear nature or function. Descartes puts into question the possibility of articulating the human as an autonomous, distinct, or even a coherent category—indeed, even as a category at all. As Jonas writes, for Descartes, "man, the supposed beneficiary of living creation . . . [is] himself an inexplicable, extraneous combination of mind and body" (Jonas 1970: 52). The search for the purpose, the finality of the human, this homeless instrument, is irrevocably tied to the question of its essence, of what sets the human apart from other phenomena of nature. This essence is no longer a divine form, but a 'natural' fact that has become hard to represent (let alone conceive) within the framework of Cartesian mechanistic biology. Descartes does not offer a clear answer. The soul-body aggregate appears to be something accidental, a contingent fact. The human is neither here nor there; it has no proper essence, but is born out of the meeting of two radically different substances. Descartes says that a human being is not just an aggregate of soul and body in the manner of a pilot in a ship, but the result of a substantial and complex relationship between the two (*Discourse*, AT VI 59; CSM I 141). The clearest experience of this union is to be found in affective states (the passions), unique to humans. Thus, the immortal soul is the exclusive property of the human, yet it does not *define* the human, for a disembodied soul would be more like an angel than a human being. Specific human traits such as personal identity or the transparency of the mind to conscious ex-

amination are also the result of embodiment, the outcome of the soul's union with the corporeal machinery. Stephen Voss argues that Descartes fails "to incorporate human beings into his new universe. . . . What is a human being? . . . I believe that, when all is said and done, [Descartes] concludes that he has no answer at all to this question" (Voss 1994: 373). Des Chene concurs: "What Descartes needed . . . was an anthropology. Why is there such a thing as a human soul? What is its place in the order of things?" (Des Chene 2001: 157).

Conclusion: The Living and Beyond

My aim here has been to pinpoint some of the sources of posthumanism in Descartes's mechanicism. I have argued that some crucial posthuman themes can be traced to the radical weakening of the realms of art and nature, machine and organism, and artifact and organ that made possible a new alliance between technology and biology, with wide-ranging consequences for future definitions of life, human nature, and technology. We have identified some of the loci of this shift in Descartes:

1) The continuity between physics, biology and technology as fields of knowledge and practice.

2) The centrality of technological metaphors for thinking the living and the human. As we have seen, the figure of the automaton has three main facets. Firstly, the automaton as *machine* or model makes possible (a) the structural visibility of the body, (b) its schematic representation as a physical system, (c) a functional understanding of its organization, and (d) an instrumental re-evaluation of its organs. Secondly, as a *spectacle*, the automaton structures a way of approaching the organism, a system of vision and representation. Thirdly, as a *simulacrum*, it poses the question of life and thought as effects of matter.

3) The reconceptualization of the organism in instrumental-mechanical terms led to the impracticality of taking natural parameters as normative schemas in the project of mastering nature.

4) The uncertainty of the place of the human in the scheme of things. Descartes's radical proposal obscured the possibility of thinking the human as ontologically unique, or as having an ideal unity, despite its privileged relationship to the immaterial. In what regards its bodily existence, the human can no longer be thought of as a bounded body with its own internal source of unity.

The problem of ruptures and continuities in the history of the sciences is a complex one, but I want to suggest some possible guidelines for a history of this progressive amalgamation of organisms and machines. I will focus in two main aspects: the scientific and cultural.

In the centuries that followed Descartes, metaphysics became embodied in experimental setups in which machines, instruments, animals, humans, and organic parts became ontologically continuous. The Cartesian shift had an important *disciplinary* dimension, as the immanent dissolution of nature and technology supported dialogues and alliances between the engineering and biological sciences. Organic substances began to be synthesized, and living elements produced from combinations of inanimate stuff. As living organisms and machines became subsets of physical systems, their fusion ceased to be a merely ontological hypothesis to become a practical reality. From the seventeenth century onwards the history of science is characterized by an increasingly dense web of technological mediation.

From its inception, the outlook of modern science has been intimately entwined with technology, both as practice and as a source of metaphors. In the more than three centuries since Descartes, technological models (in both senses of the term: analogies and experimental setups) have come to inform some key theoretical positions, such as determinism, systems thinking, reductionism and computationalism. They have also played a constitutive role in the rise of technoscientific disciplines such as robotics, cybernetics, bionics, biomechanics, artificial intelligence, human-machine interaction, neural networks, animal systems, biomimicry, and bioinformatics. Lastly, but not least, they have informed core chapters in the history of industrial and corporate management.

These three centuries have seen vertiginous change, so that no notion of machine or technology has stayed fixed for too long (let alone notions of life and biological individuality). However, some paradigmatic turns can be identified, such as classical mechanicism, thermodynamics, systems theory, cybernetics and informatics; shifts that were equally significant in the conceptual histories of machines and of living things. Also, from the eighteenth century onwards, disciplinary alliances between the biological and engineering sciences began to take place not through technological metaphors per se, but through transversal terms such as electricity, magnetism, code, system, heat, and information—conceptual entities that crossed the technological and the living.

Nowadays it is nearly impossible to think of life, body, or mind without invoking the notion of an information system; a shift that is unconceivable without a preceding tradition that already approached organisms with the mindset of an engineer.

Despite the astounding variety of theoretical approaches, experimental programs, epistemic shifts and technological innovations, the machine proved to be a robust ontological foundation, expressing a commitment to a vision of the universe (a) ruled by local, efficient causation, and (b) open to tinkering and experimentation. Remarkably, the machine accomplished this while erasing its own status as a metaphysical thesis, even posing as the very symbol of an anti-metaphysical stance.

Despite the twists and turns of history, Descartes's natural philosophy can be seen as the point of genesis of the conspicuous *asymmetry* between the terms of the machine-organism metaphor. All metaphors privilege one of their sides as the source domain of meaning: the unknown is explained in terms of the known. The centrality of technology as the source domain of models, metaphors and explanations had a patently posthuman corollary: the specificity of what these frameworks sought to explain (the living, life, human, organism, etc.) vanished in the horizon, becoming ontologically diffuse, and embedded in the technical world.

The shift we have examined did not take place in some ideal plane, but was itself the product of a knotty material web in which the conceptual and material are impossible to dissociate. While Descartes was demonstrably the first to systematically bring together the natural and the artificial, the story was not a Cartesian one; not a question of mind-matter causation. That is, the Cartesian human-automaton was not a purely conceptual synthesis that then descended into practice, producing certain historical effects in some purely mechanical fashion. These ideas and metaphors can themselves be traced to a technocultural mangle: to specific technologies, instruments, cultures, traditions, practices, and discourses. The epistemic enmeshing of organism and machine was already a material fact, embodied in the spectacular innovations of Descartes's period, such as the astronomical clock and the lifelike automaton. The Cartesian model of the human-animal body articulated together many heterogeneous and disparate dimensions of technology, and was grounded on the phenomenological and material aspects of specific historical encounters. These 'ways of being' of the machine traversed various textual, technical and socio-cultural aspects, where the machine appeared in a number of incarnations: as an object of science, spectacle, and wonder; as a symbol; as a practical problem for engineers; in the shape of scientific instruments and experimental constructs; as the abstract object of mechanics; and as the subject of illustrated treatises. All of these aspects were dense articulations of the material and the semiotic; not passive structures waiting to be mined of concepts, but actants in their own right. Descartes's wild thesis in many ways grew naturally from the cultural and scientific environment of the early seventeenth century, which had

been shaken by radical breakthroughs in anatomy, astronomy and technology. In this sense, Descartes's thesis was not a point of origin but a node of complication.

Now, this history of increasing instrumentalization of living things has some more global ramifications affecting notions of nature, culture and the human. As Bruno Latour argues, we can make sense of the conceptual history of the art-nature relation in terms of a double movement of hybridization and purification. Modernity's sleight of hand, according to Latour, consisted in multiplying hybrids (natural-social, bio-technological, etc.) while drawing a conceptual grid in which the social, natural, and technological (among other divisions of the world) were seen as ontologically pure and separate (Latour 1993). Thus, in a way, the creation of the very concepts of the human, the living and the machine were coterminous with their dissolution; they were defined at the very moment they became impossible to define. Barbara Duden writes that the notion of 'life' as a substantive is a distinctly modern creation. There is no notion of life in premodern thought; terms like *bios*, *zoe* and *psyche* are not equivalent. The absence of this substantive "only stresses the embodiment of aliveness, somewhat as the present discussion on substantive life reveals the disembodiment of contemporary discourse" (Duden 1993: 102). One of the central questions of posthumanism is how this disembodied substantive became one of the conditions of possibility for its redefinition as 'information.'

Giorgio Agamben argues that nowadays 'life' has become a curiously discarnate notion, a bare, emptied entity "separated and excluded from itself" (38).

> For anyone undertaking a genealogical study of the concept of 'life' in our culture, one of the first and most instructive observations to be made is that the concept never gets defined as such. And yet, this thing that remains indeterminate gets articulated and divided time and again through a series of caesuras and oppositions that invest it with a decisive strategic function in domains as apparently distant as philosophy, theology, politics and—only later—medicine and biology. That is to say, everything happens as if, in our culture, life were *what cannot be defined, yet, precisely for this reason, must be ceaselessly articulated and divided.* (Agamben 2004: 13, emphasis in original)

Agamben links the indefiniteness of life with that of the human, which, he argues, has always had an uncertain status among the living. In his discussion of Pico della Mirandola and Linneaus (in *The Open*), Agamben concludes that the human was posited at the very heart of the humanist tradition as an entity devoid of a proper essence, "suspended between a celestial and terrestrial nature, between animal and human—and, thus, his being [is] always less and more than itself" (Agamben

2004: 29). This is the *aporia* of humanism: the fate of the human is to be constitutively *not human;* to have no essence, be nothing and anything, to fix its own nature, receive any face: god, animal, machine, computer. Perhaps the main feature that historically distinguishes posthumanism is the role that technology plays in this picture. This is the *aporia* that posthumanism attempts to think through, mostly in celebratory or pessimistic terms: what makes us human is non-human.

Posthumanism, then, is forcing us to reconsider, among many things, the foundational myths of modernity, and to enquire into the historical and philosophical fissures at the heart of humanism. I hope this essay is a small contribution to this history.

Notes

1. We have also large and various orchards and gardens; wherein we do not so much respect beauty, as variety of ground and soil, proper for divers trees and herbs: and some very spacious, where trees and berries are set whereof we make divers kinds of drinks, besides the vineyards. In these we practise likewise all conclusions of grafting, and inoculating as well of wild-trees as fruit-trees, which produceth many effects. And we make (by art) in the same orchards and gardens, trees and flowers to come earlier or later than their seasons; and to come up and bear more speedily than by their natural course they do. We make them also by art greater much than their nature; and their fruit greater and sweeter and of differing taste, smell, colour, and figure, from their nature. And many of them we so order, as they become of medicinal use.

   We have also means to make divers plants rise by mixtures of earths without seeds; and likewise to make divers new plants, differing from the vulgar; and to make one tree or plant turn into another.

   We have also parks and enclosures of all sorts of beasts and birds which we use not only for view or rareness, but likewise for dissections and trials; that thereby we may take light what may be wrought upon the body of man. Wherein we find many strange effects; as continuing life in them, though divers parts, which you account vital, be perished and taken forth; resuscitating of some that seem dead in appearance; and the like. We try also all poisons and other medicines upon them, as well of chirurgery, as physic. By art likewise, we make them greater or taller than their kind is; and contrariwise dwarf them, and stay their growth: we make them more fruitful and bearing than their kind is; and contrariwise barren and not generative. Also

> we make them differ in colour, shape, activity, many ways. We find means to make commixtures and copulations of different kinds; which have produced many new kinds, and them not barren, as the general opinion is. We make a number of kinds of serpents, worms, flies, fishes, of putrefaction; whereof some are advanced (in effect) to be perfect creatures, like bests or birds; and have sexes, and do propagate. Neither do we this by chance, but we know beforehand, of what matter and commixture what kind of those creatures will arise.
>
> We have also particular pools, where we make trials upon fishes, as we have said before of beasts and birds.
>
> We have also places for breed and generation of those kinds of worms and flies which are of special use; such as are with you your silk-worms and bees. (Bacon 2008: 37–38)

2. For a full examination of the metaphysical legitimation of technological metaphor in Descartes, see Vaccari 2009.

3. *L'homme* first appeared in a Latin translation by Florent Schuyl (*Des Cartes de homine,* 1662), and then in French in 1664 (Claude Clerselier's *L'Homme de René Descartes et un traité sur la formation du foetus du mesme autheur*). By then, Descartes's views concerning living things had become well known through other sources, most notably the extended summary of *Monde/L'homme* in the fifth part of the *Discourse de la méthode* (1637).

4. Whenever possible, I have included references to the Charles Adam and Paul Tannery first edition of *Oeuvres de Descartes* (published between 1897 and 1913), and to the standard edition of Descartes's works in English, *The Philosophical Writings of Descartes* (Descartes 1985). This latter is referred to as 'CSM,' along with the number of the respective volume. 'CSMX' refers to *Selected Philosophical Writings of Descartes* (Descartes 1988). For *Monde/l'homme*, I have used Gaukroger's translation (Descartes 1998), referred to as 'G.' For other works of Descartes not available in the CSM edition, I have referred to the most widely available translations in English.

5. The 'animal spirits,' the early modern version of the *pneuma* of Greek tradition, have both medical and technological sources. Already in antiquity the *pneuma* crossed organic and technical contexts, most famously in the pneumatic (water and air-powered) machines codified by Hero of Alexandria in the first century CE. Descartes recontextualizes this ancient connection, combining it with other technological sources concerning the mechanics of fluids. One of the sources for Descartes's mathematical physics was the engineering tradition of the day, particularly the Dutch tradition, to which Isaac Beeckman had introduced him. Descartes's physics "would remain very dependant upon a hydrostatic/hydrodynamic model" (Gaukroger 1995: 225). As Descartes's physiology is modelled on hydraulic automata, so are his physics anchored to

a technological origin. As Gaukroger (2000) exhaustively shows, Descartes's model for physics is hydrostatics in cosmology, and statics in optics. Whereas kinematics offered a geometrical model of bodies in motion but could not account for force, statics did the opposite: traditionally it dealt with bodies in a state of equilibrium, and in terms of forces, but could not account for or model motion. Although we cannot offer a full account of these issues here, it is worth noting that Descartes was seizing on what was already a very active network of articulations between mathematical modelling, medicine, technology, and engineering practice.

6. The image of the world as theatre and fable in Descartes, and its relation to the technologies and practices of the seventeenth century, is extensively explored in Cavaillé (1991). The tropes of the fable and the theatre are intimately linked, and evoke one of the favorite themes of the baroque: life as illusion.

7. In the Aristotelian context, machines are found mainly as illustrations of efficient causation (e.g., *Generation of Animals*, 701b, 702a 20–703b; *Movement of Animals*, 734b–735a 4), which would become for Descartes the only type of cause active in nature. In Aristotle's natural philosophy, the machine already plays a distinctly metaphysical role, embodying the principle of efficient causation, also found in animate motion. It is this metaphysical aspect that legitimizes the metaphor. For Aristotle, both machines and living bodies show a tripartite division: the mover, that which is moved, and an instrument by means of which the mover accomplishes this work. The case of mechanical puppets perfectly illustrates how a single unmoved mover (in living things, the soul or souls) can generate complex motion. In at least one case (*Movement of Animals*, 702a 20–703b), Aristotle deploys the principles of mechanics in very sophisticated ways, using, for example, the notion of the fulcrum to explain the work of the joints (the points of rest between the moved and that which occasions the movement). Aristotle also illustrates this principle with the image of tool-use (a hand grabbing a stick, 702a–702b). The stick joins the chain of cause and effect that links the various bones and muscles that efficiently move each other, until we reach the originator of movement, the central governing place. So, from one perspective, the stick seamlessly joins the system of bodily motion, becoming an immanent part of the system of articulations. However, Aristotle is not yet *posthuman*, for the body has an inborn form that establishes its unity, and the stick could never be considered part of it in any natural or ontological sense. In removing this principle of unity, Descartes will welcome the tool and machine as a continuous part of the same organism, in a non-trivial way. See Aristotle (1991).

8. By the sixteenth century, the *pneuma* began to be considered a purely physical entity. Francis Bacon was the first to clearly suggest this, saying that a spirit is simply "a natural body, rarefied to a proportion, and included in the tangible parts of bodies, as in an integument. And they be no less different one from the other than the dense or tangible parts." Spirits are *bodies,* not virtues or energies; they are "thin and

invisible, and yet having place and dimension, and real." Descartes further materialized the spirits by way of an analogy with water-powered machines. Both quotes from Bacon are taken from Pyle 1995: 396.

9. Bedau argues that this is a problem with cluster definitions which outline a series of "necessary and sufficient conditions" (Bedau 1996: 335). For instance, E. Mayr offers the following list:

> All levels of living systems have an enormously complex and adaptive organization.
>
> Living organisms are composed of a chemically unique set of macromolecules.
>
> The important phenomena in living systems are predominantly qualitative, not quantitative.
>
> All levels of living systems consist of highly variable groups of unique individuals.
>
> All organisms possess historically evolved genetic programs which enable them to engage in 'telenomic' processes and activities.
>
> Classes of living organisms are defined by historical connections of common descent.
>
> Organisms are the product of natural selection.
>
> Biological processes are especially unpredictable. (quoted in Bedau 1996: 336)

Cluster conceptions of life may "deepen our sense of wonder and perplexity about what could cause this striking collection of features to be present in such an indefinite variety of natural phenomena." But an account of life should explain why these properties all coexist. "Rather than settling this question, the list raises it" (Bedau 1996: 336).

10. Opponents of the mechanical hypothesis often used this same argument. In the words of Van Ruler: "It is the paradox of mechanicism that its main thesis was justified on the very grounds on which the adversaries of the mechanical theory sought to reject it" (Van Ruler 1995: 144).

11. The Voigt-Kampff test is a fictional machine that figures prominently in the science-fiction novel *Do Androids Dream of Electric Sheep?* (Dick 1996). It also appears in the screen adaptation of the novel, *Blade Runner* (dir. Ridley Scott, 1982). The function of this machine is to measure involuntary bodily responses, thus enabling the questioner to tell if the respondent is a human or a 'replicant' (a sophisticated artificial copy, made of organic parts, but incapable of empathy). Dick named the protagonist of the novel 'Rick Deckard,' an obvious reference to René Descartes, suggesting a

Cartesian reading of the android theme (which we shall not attempt here). Descartes's original test (outlined in the *Discourse on Method*) deserves to be quoted at length:

> I made special efforts to show that if any such machines had the organs the organs and outward shape of a monkey or of some other animal that lacks reason, we should have no means of knowing that they did not possess entirely the same nature as these animals; whereas if any such machines bore a resemblance to our bodies and imitated our actions as closely as possible for all practical purposes, we should still have two very certain means of recognizing that they were not real men. The first is that they could never use words, or put together other signs, as we do in order to declare our thoughts to others. For we can certainly conceive of a machine so constructed that it utters words, and even utters words which correspond to bodily actions causing a change in its organs (e.g., if you touch it in one spot it asks what you want of it, if you touch it in another it cries out that you are hurting it, and so on). But it is not conceivable that such a machine should produce different arrangements of words so as to give an appropriate meaningful answer to whatever is said in its presence, as the dullest of men can do. Secondly, even though such machines might do some things as well as we do them, or perhaps even better, they would inevitably fail in others, which would reveal that they were acting not through understanding but only from the disposition of their organs. For whereas reason is a universal instrument which can be used in all kinds of situations, these organs need some particular disposition for each particular action; hence it is for all practical purposes impossible for a machine to have enough different organs to make it act in all the contingencies of life in the way in which our reason makes us act. (AT VI 56–57, CSMX 44–45)

12. We won't go into this here, but a full account of Descartes's 'interesting failure' at explaining embryo development can be found in Des Chene 2001.

13. For an excellent account of the debate around the problems of artifact talk in the context of biology (in particular the notion of *function*) see Lewens 2004.

14. Andrew Pickering, "The Mangle of Practice: Agency and Emergence in the Sociology of Science," in *The Science Studies Reader*, ed. M. Biagioli (New York: Routledge, 1999).

15. Jonathan Sawday has studied the fertile cross-pollination of representational techniques between technology and medical treatises from the renaissance onwards. Various techniques, such as the exploded view and the cut away, are found in both contexts, and "the visual rhetoric with which the illustrators of both the machine books and anatomy texts worked was a shared system" (Sawday 1999: 178). See also Sawday 1995. Another important context is the techniques of representation and il-

lusionism (the two are difficult to disentangle in the baroque) that are fundamental to Descartes's optics and epistemology. See also Betsy Newell Decyk (2000), Brian S. Baigrie (1996), and Martin Kemp (2000). For the origins of Descartes's natural philosophy in the engineering problems of its day (especially Descartes's relationship to Isaac Beeckman), see Gaukroger 1995.

16. See Lokhorst 2008 for a full account of Descartes's views on the physical locus of the soul-body union.

References

Ablondi, F. 1998. "Automata, Living and Non-Living: Descartes' Mechanical Biology and His Criteria for Life," *Biology and Philosophy* 13: 179–86. http://dx.doi.org/10.1023/A:1006502002257

Agamben, G. 2004. *The Open: Man and Animal*. Stanford, Calif.: Stanford University Press.

Aristotle. 1991. *The Complete Works of Aristotle,* 2 vols., ed. J. Barnes. Princeton, N.J.: Princeton University Press.

Bacon, F. 2008. *New Atlantis, or Voyage to the Land of the Rosicrucians*. Forgotten Books. Available at http://www.forgottenbooks.org/info/New_Atlantis_1000692210.php.

Baigrie, B. S. 1996. "Descartes' Scientific Illustrations and 'la grand mécanique de la nature,'" in *Picturing Knowledge: Historical and Philosophical Problems Concerning the Use of Art in Science*, ed. B. S. Baigrie. Toronto: University of Toronto Press.

Bedau, M. A. 1996. "The Nature of Life," in *The Philosophy of Artificial Life*, ed. M. Boden. New York: Oxford University Press.

Canguilhem, G. 1994. *A Vital Rationalist: Selected Writings*. New York: Zone Books.

Cavaillé, J.-P. 1991. *Descartes: La Fable du Monde*. Paris: Librairie Philosophique J. Vrin.

Chapuis, A., and E. Droz. 1958. *Automata: A Historical and Technological Study*. London: Editions du Griffon.

Cottingham, J. 1996. "Cartesian Ethics: Reason and the Passions," *Revue Internationale de Philosophie* 195: 193–216.

Decyk, B. N. 2000. "Cartesian Imagination and Perspectival Art," in *Descartes' Natural Philosophy*, ed. S. Gaukroger, J. Schuster, and J. Sutton. London: Routledge.

Descartes, R. 1965. *Discourse on Method, Optics, Geometry, and Meteorology,* trans. Paul J. Olscamp. Indianapolis: Bobbs-Merrill.

_____. 1976. *Conversation with Burman*. Oxford: Clareondon Press.

_____. 1983. *Principles of Philosophy*. Dordrecht: D. Reidel.

_____. 1985. *The Philosophical Writings of Descartes*, 3 vols., trans. J. Cottingham, R. Stoothoff, and D. Murdoch. Cambridge: Cambridge University Press.

_____. 1988. *Selected Philosophical Writings of Descartes*, trans. J. Cottingham, R. Stoothoff, and D. Murdoch. Cambridge: Cambridge University Press.

_____. 1991. *Meditations on First Philosophy*. Chicago: Encyclopedia Britannica Co.

_____. 1996. *Le Monde, L'homme*, ed. A. Bitbol-Hespériès and J.-P. Verdet. Paris: Éditions du Seuil.

_____. 1998. *The World and Other Writings*, ed. and trans. S. Gaukroger. Cambridge: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511605727

Des Chene, D. 2001. *Spirits and Clocks: Machine and Organism in Descartes*. Ithaca, N.Y.: Cornell University Press.

Dick, Philip K. 1996 (1968). *Do Androids Dream of Electric Sheep?* New York: Ballantine Books.

Dreyfus, H. L. 2001. "Telepistemology: Descartes' Last Stand," in *The Robot in the Garden: Telerobotics and Telepistemology in the Age of the Internet*, ed. K. Goldberg. Cambridge, Mass.: MIT Press.

Duden, B. 1993. *Disembodying Women: Perspectives on Pregnancy and the Unborn*. Cambridge, Mass.: Harvard University Press.

Galison, P. 1984. "Descartes's Comparisons: From the Invisible to the Visible," *ISIS* 75: 311–26. http://dx.doi.org/10.1086/353484

Gaukroger, S. 1995. *Descartes: An Intellectual Biography*. Oxford: Clarendon Press.

_____. 2000. "The Foundational Role of Hydrostatics and Statics in Descartes' Natural Philosophy," in *Descartes' Natural Philosophy*, ed. S. Gaukroger, J. Schuster, and J. Sutton. London: Routledge.

_____. 2002. *Descartes' System of Natural Philosophy*. Cambridge: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511606229

Giglioni, G. 1995. "Automata Compared: Boyle, Leibniz and the Debate on the Notion of Life and Mind," *British Journal for the History of Philosophy* 3: 249–78. http://dx.doi.org/10.1080/09608789508570917

_____. 1997. "The Machines of the Body and the Operations of the Soul in Marcello Malpighi's Anatomy," in *Marcello Malpighi: Anatomist and Physician*, ed. D. Bertoloni Meli. Firenze: Leo S. Olschki.

Grosholz, E. 1991. *Cartesian Method and the Problem of Reduction*. Oxford: Clarendon Press. http://dx.doi.org/10.1093/acprof:oso/9780198242505.001.0001

Hayles, K. N. 1999. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago: University of Chicago Press.

Jonas, H. 1970. "Spinoza and the Theory of Organism," in *The Philosophy of the Body: Rejections of Cartesian Dualism*. Chicago: Quadrangle Books.

Judovitz, D. 2001. *The Culture of the Body: Genealogies of Modernity*. Ann Arbor: University of Michigan Press.

Kemp, M. 2000. "Vision and Visualisation in the Illustration of Anatomy and Astronomy from Leonardo to Galileo," in *1543 and All That: Image and Word, Change and Continuity in the Proto-Scientific Revolution*, ed. G. Freeland and A. Corones. Dordrecht: Kluwer Academic Publishers.

Knoespel, K. J. 1992. "Gazing on Technology: Theatrum Mechanorum and the Assimilation of Renaissance Machinery," in *Literature and Technology*, ed. M. Greenberg, and L. Schachterle. London: Associated University Presses.

Latour, B. 1993. *We Have Never Been Modern*. New York: Harvester Wheatsheaf.

Lewens, T. 2004. *Organisms and Artifacts: Design in Nature and Elsewhere*. Cambridge, Mass.: MIT Press.

Lokhorst, G.-J. 2008. "Descartes and the Pineal Gland," in *The Stanford Encyclopedia of Philosophy*, http://plato.stanford.edu/entries/pineal-gland/#2.2. Accessed 20 September 2010.

Mackenzie, A. W. 1975. "A Word about Descartes' Mechanistic Conception of Life," *Journal of the History of Biology* 8(1): 1–13. http://dx.doi.org/10.1007/BF00129593

———. 1989. "Descartes on Life and Sense," *Canadian Journal of Philosophy* 19(2): 163–92.

Maull, N. 1978. "Cartesian Optics and the Geometrization of Nature," in *Descartes: Philosophy, Mathematics and Physics*, ed. S. Gaukroger. Brighton: Harvester.

Ndalianis, A. 2000. "Baroque Perceptual Regimes," *Senses of Cinema* 5. Accessed 5 May 2005 at http://archive.sensesofcinema.com/contents/00/5/baroque.html.

Pyle, A. J. 1995. *Atomism and Its Critics*. Bristol: Thoemmes Press.

Rodis-Lewis, G. 1978. "Limitations of the Mechanical Model in the Cartesian Notion of the Organism," in *Descartes: Critical and Interpretative Essays*, ed. M. Hooker. Baltimore: Johns Hopkins University Press.

Sawday, J. 1995. *The Body Emblazoned: Dissection and the Human Body in Renaissance Culture*. London: Routledge.

———. 1999. "'Forms Such as Never Were in Nature': The Renaissance Cyborg," in *At the Borders of the Human: Beasts, Bodies and Natural Philosophy in the Early Modern Period*, ed. E. Fudge, R. Gilbert, and S. Wiseman. London: Macmillan Press.

Schouls, P. A. 2000. *Descartes and the Possibility of Science*. Ithaca, N.Y.: Cornell University Press.

Sepper, D. 1996. *Descartes's Imagination: Proportion, Images, and the Activity of Thinking*. Berkeley: University of California Press.

Séris, J.-P. 1993. "Language and Machine in the Philosophy of Descartes," in *Essays on the Philosophy and Science of René Descartes*, ed. S. Voss. New York: Oxford University Press.

Sheridan, T. B., and W. R. Ferrell. 1981. *Man-Machine Systems: Information, Control and Decision Models of Human Performance*. Cambridge, Mass.: MIT Press.

Snider, A. 2000. "Cartesian Bodies," *Modern Philosophy* 98: 299–319.

Steiner, G. 2004. *Descartes as a Moral Thinker: Christianity, Technology, Nihilism*. Amherst, N.Y.: Humanity Books.

Sutton, J. 1998. *Philosophy and Memory Traces: Descartes to Connectionism*. Cambridge: Cambridge University Press.

Tabbi, J. 1995. *Postmodern Sublime*. Ithaca, N.Y.: Cornell University Press.

Vaccari, A. 2009. "Legitimating the Machine: The Epistemological Foundations of Technological Metaphor in the Natural Philosophy of René Descartes," in *Philosophies of Technology: Francis Bacon and His Contemporaries*, ed. C. Zittel, R. Nanni, G. Engel, and N. Karafyllis. Leiden: Brill Academic Publishers.

Van Ruler, J. A. 1995. *The Crisis of Causality: Voetius and Descartes on God, Nature and Change*. Leiden: E. J. Brill Publishers.

Voss, S. 1994. "Descartes: The End of Anthropology," in *Reason, Will and Sensation: Studies in Descartes's Metaphysics*, ed. J. Cottingham. Oxford: Clarendon Press.

Waldby, C. 2000. *The Visible Human Project: Informatic Bodies and Posthuman Medicine*. London: Routledge. http://dx.doi.org/10.4324/9780203360637

Wilkin, R. M. 2003. "Figuring the Dead Descartes: Claude Clerselier's *Homme de René Descartes 1664*," *Representations* 83: 38–66. http://dx.doi.org/10.1525/rep.2003.83.1.38

Woolhouse, R. 1994. "Descartes and the Nature of Body," *British Journal for the History of Philosophy* 2(1): 19–33. http://dx.doi.org/10.1080/09608789408570890

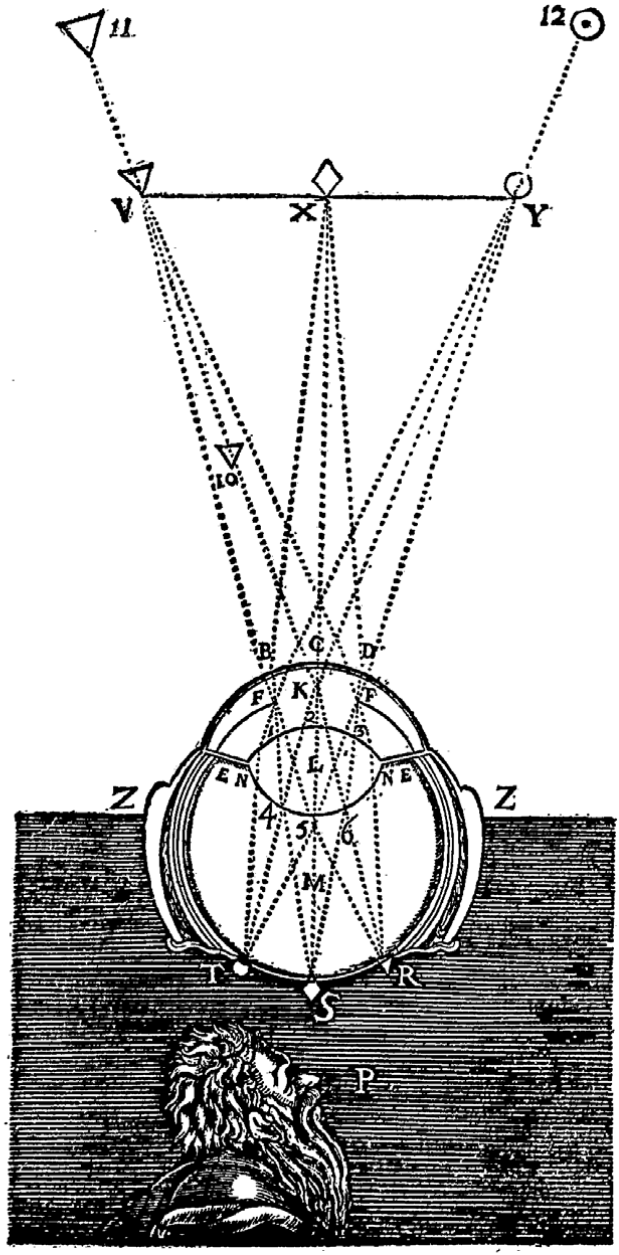

Figure 1: The functional and ontological equivalence of eye and instrument dramatized in an experiment Descartes describes at the beginning of the Fifth Discourse of the *Optics*.

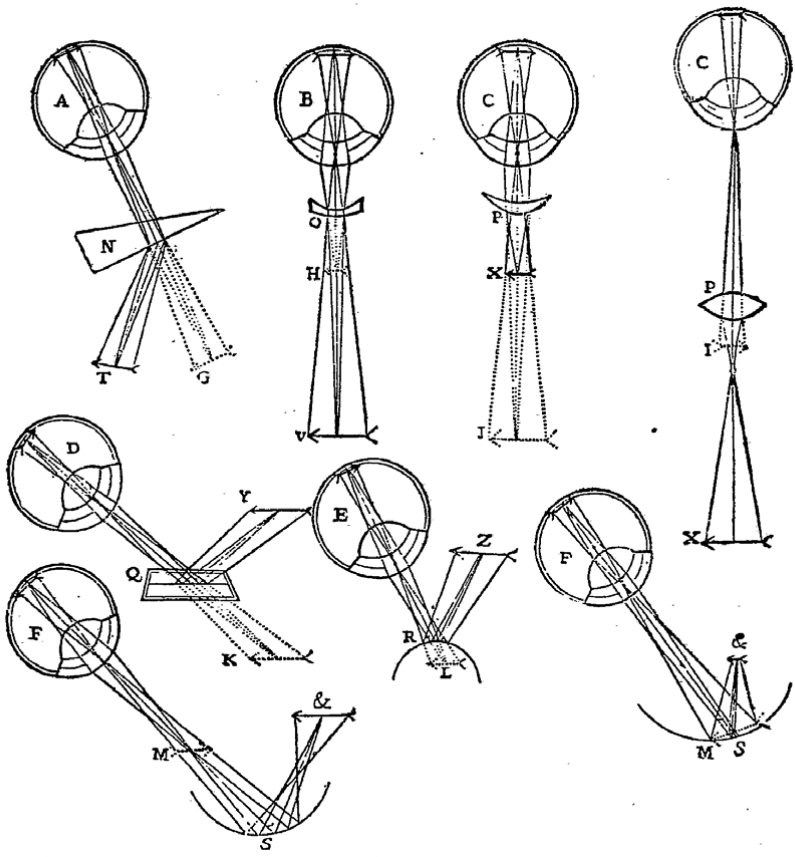

Figure 2: A series of diagrams from the *Optics*.

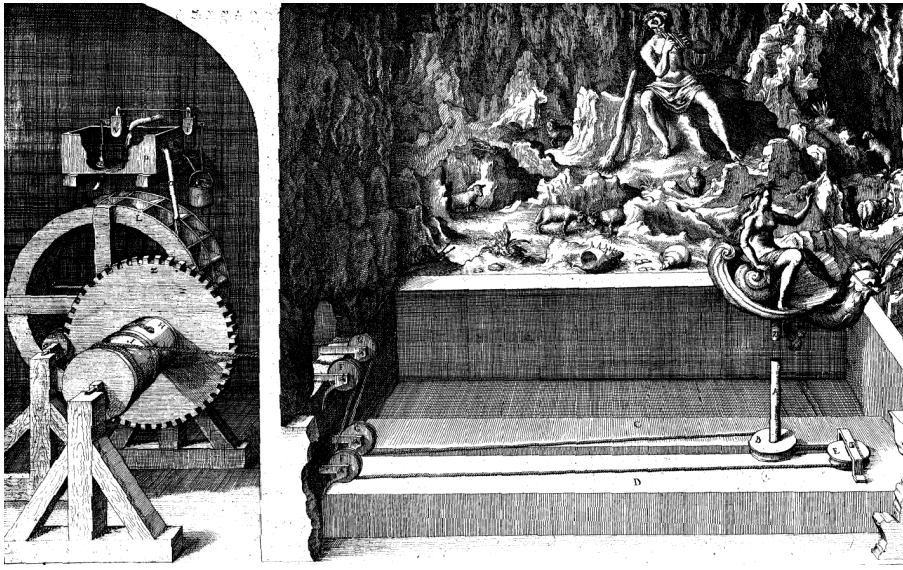

Figure 3: From *Les raisons des forces mouvants* (1620), by Salomon de Caus. "Machine with figure of Galatea pulled through the water by two dolphins."

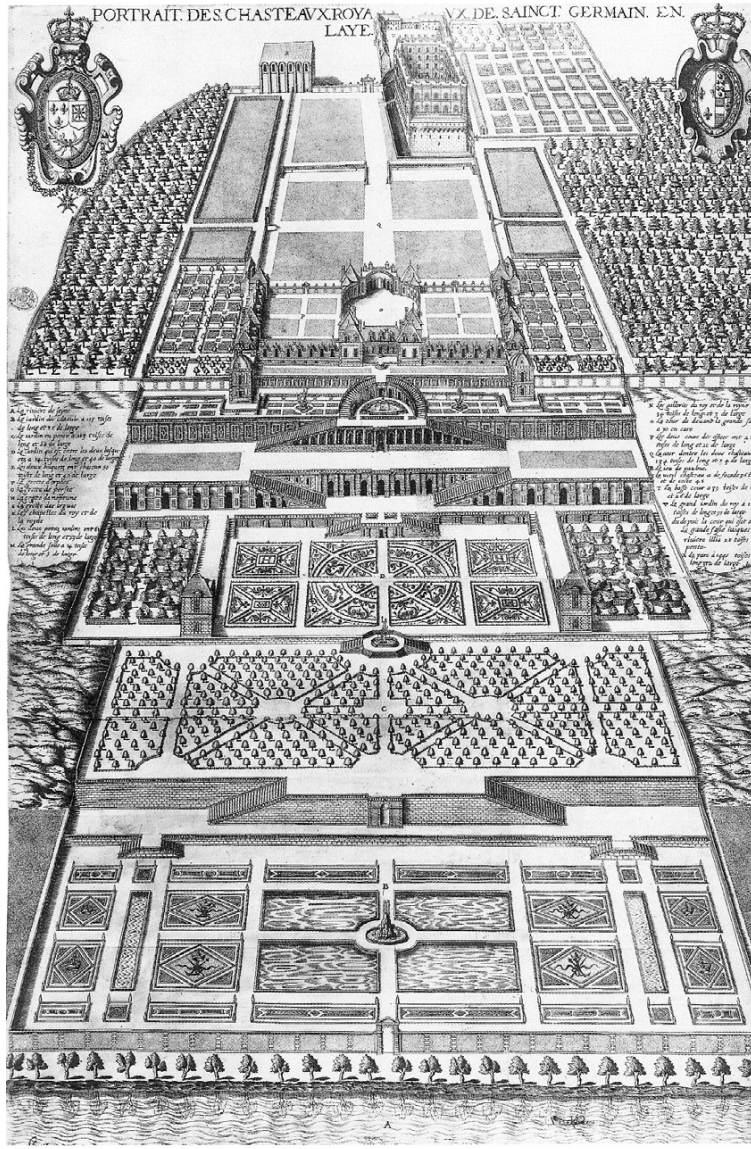

Figure 4: The royal palace of St. Germain-en-Laye, built by Philibert de l'Orme in the 1550s for Henri II. In the early seventeenth century, the brothers Tomasso and Alessandro Francini added a number of grottoes with automated scenes. This is the place Descartes refers to in *L'Homme*, and which seems to have had a deep impact on the philosopher.

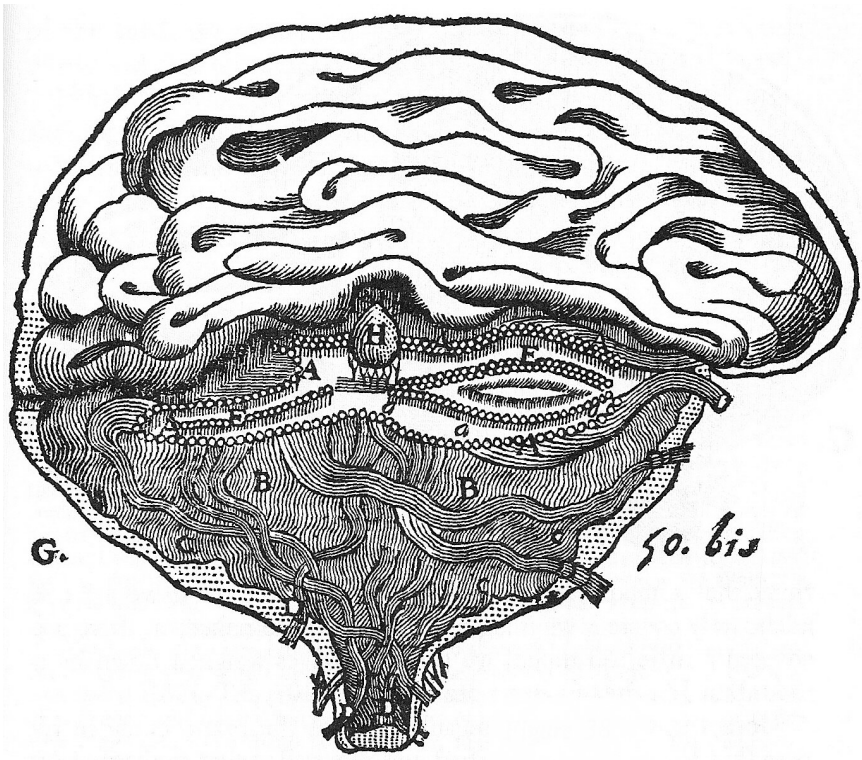

Figure 5: The brain, according to Descartes. We can see the dense arrays of tiny tubes leading in from and out of the rest of the body, ending in the openings (or pores) at the brain's central cavity, which is presided by the pineal gland (H). The image is presented in the context of an explanation of sleeping and dreaming. (From Clerselier's edition of *L'Homme*, 1664.)