Part I

The Intellectual Context

Chapter 1

Life and Works

STEPHEN GAUKROGER

In the seventeenth century, Descartes's reputation rested primarily first on his mathematics and then on his cosmology. In the eighteenth century, it shifted gradually from his cosmology to his mechanistic physiology, particularly his theory of "animal machines." In the wake of Kant's fundamental rewriting of the nature of philosophy, it was Cartesian metaphysics and epistemology that came to the fore in the nineteenth century. In Anglophone philosophy in the twentieth century, the revival of interest in empiricist epistemology, helped by the rise of positivism, resulted in skepticism being taken much more seriously as a philosophical problem, and Descartes's skeptically driven epistemology came to occupy the central ground. In French and German philosophy, by contrast, interest centered from the 1930s onwards on the ethical and political consequences of Descartes's idea of a self as independent of the world in which it finds itself, as a locus of subjectivity that is given prior to any interactions that it has with other subjects.

All these themes can be found in Descartes, as indeed can support for the eighteenth-century reading of Descartes as a dangerous materialist, as well as support for the twentieth-century reading of him as the paradigmatic dualist. These opposing positions are usually generated in the context of different projects, which have been homogenized – in the twentieth century this was achieved by taking the *Meditations* as a canonical text – in a way that hinders not only our understanding of Descartes, but also our understanding of the issues in their own right. Clarification is needed here, and considerable clarification can be achieved through a proper understanding of the development of Descartes's intellectual interests.

Early Life, 1596–1618

Descartes's mother died in childbirth just over a year after Descartes's own birth in 1596, and he had little contact with his father, who was a Councillor at the Parlement at Rennes, which required him to spend several months a year at Rennes: he moved there permanently in 1600, leaving Descartes at La Haye, where the family house was, with his grandmother. In 1606 Descartes was sent to the Jesuit College at La Flèche, one of the model colleges founded by the Jesuits at the end of the sixteenth century,

which were primarily designed to educate children of the gentry. These were boarding schools, and "total" institutions: holidays decreased from four weeks to one week a year as the child moved up the school, visits to parents outside the holidays were allowed only in dire cases, and life at the school was regulated in the finest details, with pupils subject to the exclusive authority of the masters. Yet the environment was designed to be a nurturing one, and a good deal of attention was devoted to motivating students. The aim was not to provide either an education for clerics or for the general populace. Rather, it was to make sure that those who were to take up positions of power in ecclesiastical, military, and civil life were inculcated not only with the requisite Christian values, but also with an articulate sense of the worth of those values and an ability to defend and apply them; and above all with an ability to act as paradigmatic Christian *gentileshommes*.

The first five years of the course at La Flèche were devoted to providing the student with a good knowledge of Latin, a basic knowledge of Greek, and a familiarity with a wide range of classical texts, with Cicero predominating. Most students left college after these initial five years, but some, including Descartes, stayed on. The final three years covered Aristotelian philosophy: dialectic – primarily the topics and syllogistic – then natural philosophy, including some elementary mathematics, and finally metaphysics and ethics. Theologically contentious issues were generally avoided, and the commentaries and compendia from which Descartes learned his philosophy had as their aim the reconstruction of a Christianized Aristotelianism from first principles. These textbooks were broadly Thomist in orientation, but the student was not exposed directly to Aquinas, so it is not surprising that Descartes shows no familiarity with the writings of Aquinas until around 1628. More surprising is his lack of familiarity with developments in the scholastic textbook tradition: in 1640 he wrote to Mersenne asking him for the names of scholastic textbooks, mentioning that he remembered the names of one or two authors from school but that he hadn't looked at anything in this genre for 20 years and was completely out of touch with it (AT 3:185). Descartes's philosophical interests evidently developed quite independently of his scholastic training.

On graduating from La Flèche, he spent some time in Paris before attending the University of Poitiers studying law, and perhaps some medicine, completing his law examinations at the end of 1616. He considered a career in law, but instead finally decided to join the army of Maurice of Nassau. Maurice's army was of a new kind and Descartes studied fortification, military architecture, and various other practical engineering skills. It is around this time that we find Descartes's life taking a distinctive intellectual trajectory.

Apprenticeship with Beeckman, 1618–1619

At the end of 1618, Descartes met Isaac Beeckman, eight years his senior. Beeckman had been working on natural philosophical and practical mathematics from 1613, when he had set out a novel theory of the behavior of unconstrained bodies (which later became a theory of inertia). "Physico-mathematicians are very rare," he wrote in a diary entry for December 1618, shortly after meeting Descartes for the first time, and he notes that Descartes "says he has never met anyone other than me who pursues his

studies in the way I do, combining physics and mathematics in an exact way. And for my part, I have never spoken with anyone apart from him who studies in this way." It was Beeckman who introduced Descartes to a quantitative micro-corpuscularian natural philosophy, one that he was to reshape and make into his own very distinctive system of natural philosophy.

Descartes's earliest writings, which derive from late 1618 and early 1619, deal with questions in practical mathematical disciplines. He composed a short treatise on the mathematical basis of consonance in music, exchanged letters with Beeckman on the problem of free fall, and worked with him on a number of problems in hydrostatics. The second, and particularly the third, of these exercises are of interest. In the correspondence on free fall (AT 10:58–61, 75–8, 219–22), Beeckman poses Descartes a mathematical question about the relation between spaces traversed and times elapsed in free fall, but Descartes seems keen to steer the question in the direction of dynamics, seeking the nature of the force responsible for the continued increase in motion. The move is not successful, and in fact it leads Descartes to misconstrue the original problem, but it is indicative of what will be an important and productive feature of his thinking about mechanical problems, and later about physical problems more generally.

The hydrostatics manuscripts (AT 10:67–74) are of even greater interest in this respect. Here Descartes turns his attention to a paradoxical result that Simon Stevin had proved in hydrostatics, namely that the pressure exerted by a fluid on the base of its container is independent of the amount of fluid and, depending on the shape of the vessel, can be disproportionate to the weight of the fluid. Here, Descartes takes a question which has been solved in rigorous mathematical terms and looks for the underlying physical causes of the phenomenon. He construes fluids as being made up from microscopic corpuscles whose physical behavior causes the phenomenon in question, and he asks what kinds of behavior in these corpuscles could produce the requisite effect. This is in effect an attempt to translate what Stevin had treated as a macroscopic geometrical question into a dynamically formulated micro-corpuscularian account of the behavior of fluids. In the course of this, Descartes develops a number of rudimentary dynamical concepts, particularly his notion of *actio*, which he will use to think through questions in physical optics in the mid-1620s, and then questions in cosmology in 1629. This is of particular importance because his whole approach to cosmological problems, for example, is in terms of how fluids behave, because it is fluids that carry celestial bodies around in their orbits.

By the end of 1619 Descartes's principal interest had shifted to mathematics, and this interest was stimulated by reflection upon an instrument called a proportional compass, which had limbs that were attached by sliding braces so that, when the compass was opened up, the distances between the limbs were always in the same proportion. The proportional compass enabled one to perform geometrical operations, such as trisection of angles, and arithmetical ones, such as calculation of compound interest, and Descartes asked how it was possible for the same instrument to generate results in two such different disciplines as arithmetic, which deals with discontinuous quantities (numbers), and geometry, which deals with continuous quantities (lines). Since the principle behind the proportional compass was continued proportions, he realized that there was a more fundamental discipline, which he initially identified with a theory of proportions, later with algebra. This more fundamental discipline had two

features. First, it underlay arithmetic and geometry, in the sense that, along with various branches of practical mathematics such as astronomy and the theory of harmony, these were simply particular species of it, and for this reason he termed it *mathesis universalis*, "universal mathematics." Its second feature was that this universal mathematics was a problem-solving discipline: indeed, an exceptionally powerful problem-solving discipline whose resources went far beyond those of traditional geometry and arithmetic. Descartes was able to show this in a spectacular way in geometry, taking on problems, such as the Pappus locus-problem, which had baffled geometers since late antiquity, and he was able to show how his new problem-solving algebraic techniques could cut through these effortlessly. In investigating the problem-solving capacity of his universal mathematics, however, Descartes suspected that there might be an even more fundamental discipline of which universal mathematics itself was simply a species, a master problem-solving discipline which underlay every area of inquiry, physical and mathematical. This most fundamental discipline Descartes termed "universal method," and it is such a method that the *Regulae* sought to set out and explore.

The *Regulae*, 1619–1628

When Descartes began work on the *Regulae*, it was intended to be in three parts, each part to contain twelve "Rules." What was offered was a general treatise on method, covering the nature of simple propositions and how they can be known (first twelve Rules), and how to deal with "perfectly understood problems" (second set of Rules) and "imperfectly understood problems" (projected third set). The composition proceeded in two stages, however, and the nature of the work shifted somewhat between stages. In 1619–20 Descartes completed the first eleven Rules, and then apparently abandoned the project. When he took up the *Regulae* again in 1626–8, he revised two of these (Rules 4 and 8) and added Rules 12 to 18, with titles only for Rules 19–21. The thrust of the work remains methodological, and mathematics is still taken very much as the model – which is what we would expect, since the fact that the move to universal method comes through universal mathematics is what provides the former with its plausibility. But the completed Rules of the second part, particularly Rules 12–14, focus on the question of how a mathematical understanding of the world is possible by investigating just what happens in quantitative perceptual cognition, that is, just what happens when we grasp the world in geometrical terms.

Descartes's thinking on perceptual cognition was doubtless stimulated by his work in optics. He settled in Paris in 1625, and began working on optics partly in collaboration with Claude Mydorge. Some time between 1626 and 1628, he discovered the sine law of refraction, and on the basis of this he was able to establish what curvature the surface of a lens needed if it was to refract parallel rays striking its surface to a single point. Spherical surfaces were unable to do this, and as a result the spherical sections used as lens did not form a single clear image, which was an immense drawback, especially in telescope lenses. At this time he also attempted to develop a physical theory of light which would explain why light behaved in particular geometrically circumscribed ways when reflected and refracted. His work on the way in which the visual system in

animals worked resulted in a naturalized account of perceptual cognition (Rules 12–14 of the *Regulae*, later developed in more detail in *L'Homme*) in which he began to think through questions of our perceptual representation of the world. One general question that guided his work on representation was whether there was a way of representing information in such a way that its truth or falsity would be immediately manifest. Descartes believed he had found such a means of representation in the case of mathematics, and the aim was to generalize this in the form of a "universal method."

Specifically, the problem that Descartes faced was that universal method was supposed to provide a general form of legitimation of knowledge, including mathematical knowledge, but algebra also provided its own specific kind of legitimation of mathematical knowledge. The point at which the *Regulae* break off and are abandoned is exactly that at which it becomes clear that these two forms of legitimation come into conflict. The general form of legitimation provided by universal method is one in which problems are represented in the form of clear and distinct ideas, and Rule 14 spells out just what this means in the case of mathematics: it means representing the pure abstract entities that algebra deals with in terms of operations on line lengths, and in this way the truth or falsity of the proposition so represented is evident. To take a simple example, the truth of the proposition $2 + 2 = 4$ is not immediately evident in this form of representation, but it is evident if we represent the operation of addition as the joining together of one pair of points, **:**, with another, **:**, and we see that the sum is **::** (Descartes uses line lengths but the principle is the same). In this case we can see how the quantities combine to form their sum (and this is just as evident in the case of very large numbers the numerical value of whose sum we cannot immediately compute). This is a very insightful and profound move on Descartes's part. The problem he is concerned with is that of identifying those forms of mathematical demonstration in which we can grasp not merely that the solution or conclusion follows from the premises, but in which we can track how the solution or conclusion is generated. The difficulty that arose was that the range of operations for which this kind of basic legitimatory procedure held did not extend to the more sophisticated kinds of operation with which Descartes's algebra was able to work. And it is just such operations that begin to be envisaged in Rules 19–21, namely the extraction of higher-order roots, where no manipulation of line lengths is going to generate the result.

It is at this point that the *Regulae* are abandoned, and this also marks the end of the attempt to model knowledge on mathematics, at least in anything other than a merely rhetorical sense. When mathematics is invoked from now on, it will be invoked as a paradigm of certainty, but, in contrast to the work of the 1620s, it will cease to be accompanied by an attempt to capture at any level of mathematical detail just what this certainty derives from or consists in. Indeed, Descartes's interest in methodological questions in his later writings comes to be overdetermined by metaphysical, epistemological, and natural philosophical issues.

Le Monde and *L'Homme*, 1629–1633

In 1630 Descartes moved to the Netherlands, which was to be his home for the next twenty years, and from the end of 1629 he began work on a new project, which was

originally intended to be in three parts. The first part (*Le Monde*) would cover inanimate nature, the second (*L'Homme*) would cover animal and human non-conscious functions, and these were to have been complemented by a third part, on the "rational soul," which never appeared.

Le Monde sets out a theory of the physical world as something consisting exclusively of a homogeneous matter, which can be considered as comprising three types of corpuscle, distinguished solely by size. On the basis of laws describing the motion of these corpuscles, a mechanistic cosmology is set out which includes both a celestial physics and an account of the nature and properties of light. Descartes begins with an argument to the effect that the world may be different from our perceptual image of it, and indeed that our perceptual image may not even be a reliable guide to how the world is. This is in no sense a skeptical argument, and once Descartes has established the nature of the world, it is clear that we can know it to be very different from our perceptual image of it.

Matter theory is developed in a systematic way in *Le Monde*. The general principle from which Descartes works is that, given that all bodies can be divided into very small parts, a force is required to separate these parts if they are stationary with respect to one another, for they will not move apart of their own accord. If the very small parts of which the body is constituted are all at rest with respect to one another, then it will require significant force to separate them, but if they are moving with respect to one another, then they will separate from one another at a rate which may even be greater than that which one could achieve by applying a force oneself. The former bodies are what we call solids, the latter what we call fluids, and in the extreme cases they form the ends of a spectrum on which all bodies can be ranked, with rigid solids at one terminus and extremely fluid bodies at the other. This ranking on a spectrum of fluidity provides the basis for Descartes's theory of matter, for it enables him to reduce the properties of matter to the rate at which its parts move with respect to one another.

All bodies, whether fluid or solid, are made from the one kind of matter on this account. Descartes famously argues that there are no interstitial vacua in matter: the universe is a plenum. Moreover, he argues that even if one assumed there were vacua, the degree of fluidity of a body would not be proportional to the amount of vacuum that exists between its constituent parts because the parts of a liquid would be more readily compressed into a continuous whole than would be the parts of a solid. On his account of matter, if we strip the world of the traditional forms and qualities, what we would be left with would be its genuine properties. This new world is to be conceived as "a real, perfectly solid body which uniformly fills the entire length, breadth, and depth of the great space at the center of which we have halted our thought" (AT 11:33). This perfectly solid body is "solid" in the sense of being full and voidless, and it is divided into parts distinguished simply by their different motions. At the first instant of creation, God provides the parts with different motions, and after that he does not intervene supernaturally to regulate their motions. Rather, these motions are regulated by three laws of nature, set out in chapter 7 of *Le Monde*: first, a body will always continue in its state of motion unless stopped or retarded by another body; second, in collisions between such bodies the total amount of motion is conserved; third, whatever the path of a moving body, its tendency to motion is always rectilinear.

Using the theory of matter and laws of nature which have now been elaborated, Descartes now sets out the details of a heliocentric cosmology in the form of an account of a hypothetical "new world." The key to this whole cosmology is Descartes's account of vortices. Because the universe is a plenum, for any part of it to move it is necessary that other parts of it move, and the simplest form of motion which takes the form of displacement is going to be a closed curve, although we have no reason to think that the universe turns around a single center: rather, we may imagine different centers of motion. The matter revolving furthest away will be the largest or most agitated because it will describe the greatest circles, owing to its greater capacity to realize its inclination to continue motion in a straight line, for the larger the circle, the closer it approximates a straight line. Whatever differences in size and agitation we may imagine there to have been in the early stages of the universe, however, except for the large clumps of the third element (see below), we can imagine that the constant motion and collision caused the difference in sizes of matter to be reduced as "the larger pieces had to break and divide in order to pass through the same places as those that preceded them." Similarly, differences in shape gradually disappear as repeated collisions smooth off the edges and all matter (of the second element) becomes rounded. Some pieces of matter are sufficiently large to avoid being broken down and rounded off in this way: these are what Descartes refers to as the third element, and such pieces of matter form the planets and the comets. Finally, the collisions yield very small parts of matter, which accommodate themselves to the space available so that a void is not formed, but this first element is formed in a greater quantity than is needed simply to fill in the spaces between pieces of the second and third element, and the excess naturally moves towards the center because the second element has a greater centrifugal tendency to move to the periphery, leaving the center the only place for the first element to settle. There it forms perfectly fluid bodies which rotate at a greater rate than surrounding bodies and which extrude fine matter from their surfaces. These concentrations of the first element in the form of fluid, round bodies at the center of each system are suns, and the pushing action at their surfaces is "what we shall take to be light."

The universe, as Descartes represents it, consists then of an indefinite number of contiguous vortices, each with a sun or star at the center, and planets revolving around this center carried along by the second element. Occasionally, however, planets may be moving so quickly as to be carried outside the solar system altogether: then they become comets. Descartes describes the difference between the paths of planets and comets in terms of an engaging analogy with bodies being carried along by rivers: the latter are like bodies that will have enough mass and speed to be carried from one river to another, whereas the former are like bodies that are just carried along by the flow of their own river. Planets eventually enter into stable orbits – the less massive they are, the closer to the center – and once in their orbits they are simply carried along by the celestial fluid in which they are embedded. The stability of their orbits arises because, once a planet has attained a stable orbit, if it were to move inward it would immediately meet smaller and faster corpuscles of the second element which would push it outward, and if it were to move outward, it would immediately meet larger corpuscles which would slow it down and make it move inward again.

Descartes's achievement in *Le Monde* is twofold. In the first place, his vortex theory explains the stability of planetary orbits in a way that presents an intuitively plausible

picture of orbital motion which requires no mysterious forces acting at a distance: the rapid rotation of the sun at the center of our solar system, through its resultant centrifugal force, causes the "pool" of second matter to swirl around it, holding planets in orbits as a whirlpool holds bodies in a circular motion around it. Moreover, it explains this motion in terms of fundamental quantifiable physical notions, namely centrifugal force and the rectilinear tendencies of moving matter. In other words, the heliocentric theory is derived from a very simple theory of matter, three laws of motion, and the notion of a centrifugal force. Secondly, this account also enables Descartes to account for all the known principal properties of light, thereby providing a physical basis for the geometrical optics that he had pursued so fruitfully in the 1620s.

The second part of the project, *L'Homme*, is part of the same enterprise in natural philosophy, extending the mechanist program into physiology, and relying on the matter theory and mechanics established in *Le Monde*. In some ways, *L'Homme* was even more radical than *Le Monde*. The idea that mechanism might allow one to account for everything from physical processes to the behavior of celestial bodies was certainly contentious, not least in the Copernican consequences that Descartes draws from this. But the project was common ground among quite a few natural philosophers in the 1630s: Beeckman, Mersenne, and Gassendi, for example. A mechanistic physiology was a different matter: this was both far more ambitious and far more threatening. In *Le Monde*, Descartes postulated a single kind of matter in the universe and this matter is inert, homogeneous, and qualitatively undifferentiated. The boundaries of bodies are determined by motion relative to surrounding matter and any variation in properties is a function of the size, speed, and direction of the matter. It is with this notion of matter that Descartes attempts to account for all functions and behavior of animals.

Animal physiology is introduced right from the beginning of *L'Homme* as the workings of a machine. The digestion of food is described in a mixture of mechanical and chemical terms. The food is first broken down into small parts and then, through the action of heat from the blood and that of various humours which squeeze between the particles of blood, the food is gradually divided into excrementary and nutritive parts. The heat generated by the heart and carried in the blood is the key ingredient here, and Descartes devotes much more attention to the heart and the circulation of the blood than to functions such as digestion and respiration. He accepts that blood circulates throughout the body, but like most of his contemporaries rejects Harvey's explanation of circulation in terms of the heart being a pump, preferring to construe the motion as being due to the production of heat in the heart. The heart is like a furnace, or rather like the sun, for it contains in its pores "one of those fires without light," which are comprised of the first element that also makes up the sun. In fact, Descartes really had little option but to reject Harvey's account. To accept that the motion of the blood was due to the contractive and expansive action of the heart would have required providing some source of power for its pumping action, and it was hard to conceive how he could do this without recourse to non-mechanical powers, whereas at least he can point to phenomena such as natural fermentation in defending his own account of thermogenetic processes creating pressure in the arteries. The most important features of the circulation of the blood from the point of view of Cartesian psychophysiology is the fact that it carries the "animal spirits," which it bears up through the carotid arteries into the brain. These are separated out from the blood and enter the brain through the

pineal gland, at the center of the cerebral cavities. This is a mechanical procedure in that the animal spirits are the subtlest parts of the blood and hence can be filtered into the pineal gland through pores too fine to admit anything larger (AT 11:128).

Having dealt with the heart – the heat of which is the "principle of life" – and the circulation of the blood, Descartes now turns (AT 11:130) to the nervous system. The nervous system works by means of the animal spirits, which enter the nerves and change the shape of the muscles, which in turn results in the movement of the limbs, an analogy being drawn with the force of water in fountains. In general terms, what happens is that external stimuli displace the peripheral ends of the nerve fibers, and a structural isomorph of the impression made on the sense organ is transmitted to the brain. This results in changes in the patterns formed by the animal spirits in the brain, which can produce changes in the outflow of spirits to the nerves. At the muscle, a small influx of spirit from the nerve causes the spirits already there to open a valve into its antagonist. Spirits then flow from the antagonist which causes it to relax, as well as causing the first muscle to contract.

The two greatest challenges for Descartes's mechanized physiology lie in two areas which had traditionally been treated as unproblematically goal-directed: the formation of the fetus, and perceptual cognition. In the case of fetal development, Descartes's aim, in *L'Homme* and in the later physiological text *Description du corps humain*, is to show that a perfectly good account of this can be given which makes no reference to intrinsic goals at all.

Most biological processes can be thought of in goal-directed terms: nutrition, respiration, excretion, sleep, etc. But then many non-biological physical processes can also be thought of in goal-directed terms, and Aristotle had argued that the explanation of the fall of heavy bodies to the ground had to display the goal-directedness of this process. This raises the problem of where we draw the line. We may concede that a process can be described in terms of a goal without conceding that goal-directedness plays any genuine part in explaining the process. Unless we think that teleology must play a part in every natural organic process, for example, we will not be inclined to think that growth in adolescents or adults requires explanation in terms of ends or goals. On the other hand, we may be inclined to think that the development of the fetus does require an explanation in terms of ends or goals: it develops in this way because it is developing into a horse, or a person, or a bird. In the middle of these two is a gray area. We can think of Descartes's strategy as pushing fetal development into the gray area, in which case the question of the right kind of explanation will no longer be judged by *a priori* considerations about whether goals are relevant, but by how effective whatever concrete explanation one comes up with is in accounting for the detail. More schematically, although Descartes does not lay out his plan for dealing with this question explicitly, it seems clear that a threefold strategy must lie behind any thoroughgoing mechanist approach to embryology. First, ordinary growth is accounted for in a way that makes no references to goals. Secondly, the process of formation and maturation of the fetus is treated simply as a species of growth: it involves a significantly greater increase in complexity and internal differentiation of parts than the process of growth from childhood to adulthood, of course, but this in itself does not make it qualitatively different. Third, the mechanist must show how the development from a low degree of complexity and internal differentiation to a high degree of complexity and differentiation is

something that can be handled in mechanistic terms. What this strategy allows one to do is to provide a general account of growth, in terms of how raw material is introduced into the organism from outside and transformed into the kinds of highly differentiated material making up bones, blood, muscle, etc. Then, having done this, one shows how the kind of account developed in this way can be extended to the case where the organs are not simply being increased in size but are actually being formed anew.

Descartes allows a form of genuine perceptual cognition in animals, whom he considers to be strictly mindless, and his highly naturalistic account of cognition in "automata" also applies to many features of human cognition. But unlike fetuses, human beings harbor intrinsic goals, above all the goal of understanding the world, and human cognition can be criticized to the extent to which it fails to achieve that goal.

Skeptically Driven Epistemology, 1633–1641

Le Monde and *L'Homme* were suppressed by Descartes on hearing of the condemnation of Galileo, and they did not appear in his lifetime. Galileo's *Dialogue Concerning the Two Chief World Systems* was condemned by the Roman Inquisition on July 23, 1633, and the condemnation had clear implications for *Le Monde*. Galileo's *Dialogue* provided physical evidence both for the Earth's diurnal rotation, in the tides, and for its annual orbital motion, in cyclical change in sunspot paths. The Inquisition's condemnation focused on the question of the physical reality of the Copernican hypothesis. A core issue was "a matter of faith and morals" which the second decree of the Council of Trent had given the Church the sole power to decide. Opponents of Galileo treated scripture as a source of scientific knowledge, and argued that the case was covered by the criterion that stated that the Church Fathers, if they agreed on something, cannot err on dogmas of the faith. In the 1633 condemnation this interpretation was effectively established, and this meant that the physical motion of the Earth could not be established by natural philosophical means. Thus not only did the kind of argument that Galileo had offered in the *Dialogue* have no power to decide the issue, but neither did the kind of arguments that Descartes had offered in *Le Monde*.

Descartes's reaction to this was twofold. In the first place, he collected some of his scientific work that was untouched by the 1633 condemnation and published this as three essays, on optics, meteorology, and geometry. The cosmological setting for Descartes's theory of light is ignored in the *Dioptrique*, where the concern is with geometrical optics, rather than physical optics, and the contentious cosmological consequences of his physical optics are avoided. Most of the material in the essay on meteorology is very traditional, but one section, that on the rainbow, is novel, and indeed Descartes identifies it as the example of his "method." It is of interest in countering those views of Descartes that construe him as deducing his results in natural philosophy from first principles, for the procedure adopted there offers an experimental means of sifting empirical hypotheses, and offers a model of how to quantify optical phenomena.

The second kind of reaction, offered in the *Discourse* and the *Meditations*, was more radical. The ultimate outcome of the crisis provoked by the condemnation of Galileo's

heliocentrism was a new direction in Descartes's work. He does not abandon interest in natural philosophy, and to the end of his life continues to think it has been his most important contribution. In a letter to Princess Elizabeth of Bohemia of June 28, 1643, he tells her that the principles of metaphysics must be understood, but once understood one need spend no more time upon them. Rather, one should then proceed to devoting one's time "to thoughts in which the intellect co-operates with the imagination and the senses" (AT 3:695), that is, natural philosophy. The same point is made to Burman in 1649, Descartes insisting that one should not waste too much time on metaphysical questions, especially his *Meditations*, as these are just preparation for the main questions, which "concern physical and observable things" (AT 5:165).

But Descartes's interest in natural philosophical areas such as optics, mechanics, and cosmology after 1633 is confined largely, if not exclusively, to polemics and systematization, and above all to the legitimation of a mechanist natural philosophy by metaphysical and epistemological means, a completely different enterprise from that pursued in the pre-1633 works, of which *Le Monde* and *L'Homme* are the culmination. Setting out the kind of metaphysics that gives just the right fit with his natural philosophy, indeed grounds the kind of natural philosophy he wants, is the preoccupation of the *Meditations* and the first Part of the *Principia*, which reworks the *Meditations*.

The *Meditations* use a skeptically driven epistemology to systematically strip down the world – the world of common sense and the world of Aristotelian natural philosophy – so that the assumptions that lie behind this picture are laid bare, and found wanting. Descartes then proceeds to build up the world metaphysically from first principles, using a notion of clear and distinct ideas, backed up by a divine guarantee. What this yields is a sharp distinction between the mind and the corporeal realm, and an account of the corporeal realm radically different from that with which the *Meditations* began. Because our new starting point is clear and distinct ideas (the paradigm for which is the *cogito*), we cannot ask about the existence of the corporeal world without having a clear and distinct idea of what it is that we are asking for the existence of. The question of existence only becomes determinate, and thereby answerable on Descartes's account, when we ask whether something with particular characteristics exists, where the characteristics in question are not only fully specified but securely grasped. Unless we start from things that we clearly and distinctly grasp we can never be sure we are actually getting anywhere. The question is whether there are any conceptions of the corporeal world available to us which offer a grasp of this kind. Descartes's answer is that he knows of only one, namely a mathematical grasp of the world. Corporeal things, he tells us at the end of the *Meditations*, "may not all exist in a way that exactly corresponds with my sensory grasp of them, since sensory understanding is often very obscure and confused. But at least they possess all things that I perceive in them clearly and distinctly, that is to say, all those things which, generally speaking, come under the purview of pure mathematics" (AT 8A:80).

If the arguments of the *Meditations* go through, what Descartes has established is that our starting point in natural philosophy must be a world stripped of all Aristotelian forms and qualities, and consisting in nothing but geometrically quantifiable extension. The only natural philosophy compatible with such a picture is mechanism, in particular, mechanism of the kind set out by Descartes in the matter theory and mechanics of *Le Monde*. If we grant him his matter theory, and two of the basic principles of his

mechanics, the principle of rectilinear inertia and that of centrifugal force, then, if the argument of *Le Monde* is correct, we have heliocentrism, for this is all he needs. In this way, the *Meditations* connect up directly with *Le Monde*, providing a metaphysical route to the natural philosophy of the latter and providing a legitimation of the whole enterprise.

A System of Philosophy, 1641–1644

The year in which Descartes prepared the *Meditations* for publication marked the beginning of an acrimonious five-year period in which Descartes was publicly attacked by the Dutch theologian Gisbert Voetius. Descartes's follower Regius had alienated a number of his colleagues with his polemics on behalf of Cartesianism, and Voetius, failing to have Regius removed from his chair of medicine at Utrecht, directed his attacks at Descartes. At this time, Descartes was preparing to connect his natural philosophy to his new legitimatory foundations, in the *Principia*, the first four books of a projected six appearing in 1644.

The *Principia* begins with what is, despite a reordering of some arguments, in effect a summary of the *Meditations*, but it does not simply lead into *Le Monde*. Much the same ground is covered, but the material is reworked in terms of a metaphysical vocabulary of substance, attributes, and modes wholly absent from *Le Monde*, and not required for its natural philosophical focus (as opposed to the legitimatory thrust of the *Principia*). This metaphysical rewriting of Cartesian natural philosophy provides it with a wholly new focus, as questions of the legitimacy of this way of proceeding in natural philosophy overshadow those of how specifically natural philosophical processes are to be understood. Nevertheless, the metaphysical apparatus set out in the first part of the *Principia* is not an optional extra. What Descartes wants to show is that his system of natural philosophy is the only one that meets a set of stringent foundational requirements, requirements which must be satisfied if one is even to begin setting out a natural philosophical system. These requirements turn on the question of clarity and distinctness. The key move in Descartes's foundational strategy is the use of skeptical doubt to force open the question of what our starting point in any cognitive enterprise should be, and to establish clear and distinct ideas as the only possible starting point. This is reinforced by his insistence that we cannot even ask about the existence of something unless we have a clear and distinct grasp of what it is that we are asking about: only if the world is conceived in a particular way can we begin to inquire into its existence and ask what properties it has.

This way of proceeding depends on an understanding of metaphysics as something guided by epistemological concerns (in the form of the doctrine of clear and distinct ideas), and on an understanding of epistemology as being driven in turn by natural philosophical considerations. On the first question, it is worth noting, for example, that when Descartes's account of substance in Book I of the *Principia* turns out to yield two incompatible definitions (arts 51 and 52), he resolves this by ignoring metaphysical considerations and settling the question via the doctrine of clear and distinct ideas (arts 54 and 60), so that it is now the fact that our clear and distinct conceptions of God, mind, and matter are completely different from each other that secures their

status as independent kinds, and no longer considerations of substance. On the question of the role of natural philosophy, one needs only to compare Books II to IV of the *Principia* with *Le Monde* to realize that the role of the epistemologized metaphysics of Book I is that of providing a legitimating foundation for a system of natural philosophy which has already been developed without the benefit of these legitimating foundations.

Yet Descartes is adamant that what marks out his system from others is that it is the only ultimately legitimate one, and when in 1646 his erstwhile follower Regius published his own version of Cartesian natural philosophy, which dispensed with any of Descartes's legitimatory apparatus, Descartes immediately distanced himself from it and attacked Regius, in 1648 publishing his *Notae in programma*, a point-by-point response to Regius, in which the errors to which one is subject when one has not thought through the questions in basic foundational terms are exposed.

The Passions of the Soul, 1643–1650

In 1643 Descartes began an affectionate and fruitful correspondence with Princess Elizabeth of Bohemia, who was at that time 24. He did not see her very frequently between 1643 and 1646, when she departed from the Netherlands, but he clearly had a strong personal attachment to her right up to his death. Elizabeth pressed Descartes on a number of questions about the passions, raising issues of the mind-body relationship and ethics. In the context of affective states, he returns to the largely naturalistic account that guided his account of cognitive states in *L'Homme*. In this correspondence he distinguishes "three kinds of primitive notions," namely the mind, the body, and the union of the two (AT 3:691), and it is the union of the two – that is, for all intents and purposes, embodied mind – that does all the work as far as mind is concerned, for disembodied mind plays no role in perceptual cognition, and it is far from clear what role it plays in the more problematic case of intellectual cognition. Nevertheless, it is crucial for Descartes's program that the sharp distinction between mind and body not be blurred (he rejects the almost universally held conception of higher and lower faculties on these grounds). This is, I believe, primarily because his ethics requires him to conceive of the human mind as distinctive, in that we can stand back from our cognitive and affective states and make judgments about them, and for this human being must have a unified locus of subjectivity, over and above the modularized corporeal faculties we share with animals.

In 1649 Descartes left the Netherlands for the court of Queen Christina of Sweden. The move does not seem to have been a success. The dominant intellectual influence at the court was the Dutch humanist Isaac Vossius, and his understanding of an intellectual culture was very different from that of Descartes, effectively marginalizing Descartes, despite his greater reputation. The winter of 1649/50 was the coldest one for sixty years, and Descartes caught pneumonia. Refusing the attentions of Christina's personal physician, Johan van Wullen, who had sided with the Dutch theologian Regius in a vicious attack on Descartes's work, he followed his own cure of wine flavored with tobacco. This was not a success and he died on February 11, 1650. His remains were returned to France in 1666, exhumed several times, and his skull, which

was removed from the rest of the remains in 1666, now rests in the *Musée de l'homme* in Paris.

References and Further Reading

Baillet, A. (1991). *La Vie de Monsieur Descartes*, 2 vols. Paris: Horthemels.

Beeckman, I. (1939–53). *Journal tenu par Issac Beeckman de 1604 à 1634*, ed. Cornelius de Waard, 4 vols. The Hague: Nijhoff.

Descartes, R. (1998). *The World and Other Writings*, trans. Stephen Gaukroger. Cambridge: Cambridge University Press.

Garber, D. (1992). *Descartes' Metaphysical Physics.* Chicago: University of Chicago Press.

Gaukroger, S. (1995). *Descartes, An Intellectual Biography.* Oxford: Oxford University Press.

Gaukroger, S. (2002). *Descartes' System of Natural Philosophy.* Cambridge: Cambridge University Press.

Rodis-Lewis, G. (1971). *L'Œuvre de Descartes*, 2 vols. Paris: J. Vrin.