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Descartes on Time and Duration

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Abstract
Descartes' account of the material world relies heavily on time. Most importantly, time is a component of speed, which figures in his fundamental conservation principle and laws. However, in his most systematic discussion of the concept, time is treated as somehow reducible both to thought and to motion. Such reductionistic views, while common among Descartes' late scholastic contemporaries, are very ill-suited to Cartesian physics. I show that, in spite of the apparent identifications with thought and motion, Cartesian time retains—in the form of what I will call 'successive duration'—precisely the intrinsic structure necessary to serve as an independent parameter of quantitative physics. As is often the case with Descartes, he gives the impression of embracing traditional doctrines while in fact radically transforming the underlying concepts to serve his scientific agenda. His theory of time, though formulated in Aristotelian terms, anticipates Newton in important respects.

Keywords
René Descartes (1596-1650), 17th century science: time and space

1. Introduction

Descartes' account of the material world relies heavily on time. Most importantly, time is a component of *speed*, which figures in his fundamental conservation principle. Thus, the first and third laws of motion are grounded on the principle that God gives the universe a certain total *quantity of motion* (size × speed) in the beginning and thereafter conserves that quantity so that, for example, "if one part of matter slows down we must assume that some other part of matter of equal size speeds up by the same amount."[1] Likewise, the seven more detailed collision

[1] AT 8A 61; CSM 1 240. Hereafter, 'AT' refers to René Descartes, *Oeuvres de Descartes*,

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rules involve the scalar 'degree of speed' (*gradus celeritatis*). The second law of motion also depends on temporal considerations, though it concerns the direction, rather than quantity, of motion. This law states that all motion is rectilinear in tendency, because God "always conserves motion in the precise form in which it is occurring at the very moment of time he conserves it, without taking account of the motion which was occurring a little while earlier."[2] So motion tends to be rectilinear because it is divinely conserved over time, moment by moment.[3] Indeed, the doctrine of divine conservation itself, from which all of Descartes' physical laws and principles are ultimately derived, depends crucially on a certain feature of time, namely that its parts are all "completely independent" of one another.[4] With respect to specific physical processes, Descartes is careful to distinguish between those which have duration and those which are instantaneous. For example, while it is true that "no motion takes place in a single instant of time,"[5] the actions produced by nerve impulses and light rays are instantaneous.[6] Finally, since bodies in the plenum are individuated only by the relative motions of its parts[7], and motion occurs only in time, it follows that without time the Cartesian universe would be an undifferentiated blob.

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ed. Charles Adam and Paul Tannery, 11 vols. (Paris, 1996). [8A = vol. 8, part A, 61 = p. 61]; 'CSM' refers to *The Philosophical Writings of Descartes*, ed. John Cottingham, Robert Stoothoff, and Dugald Murdoch, 2 vols. (Cambridge, 1984-1985) [1 = vol. 1, 240 = p. 240]; 'CSMK' refers to *The Philosophical Writings of Descartes: The Correspondence*, ed. John Cottingham, Robert Stoothoff, Dugald Murdoch, and Anthony Kenny (Cambridge, 1991).

2) AT 8A 64; CSM 1 242.

3) Why it follows from moment-to-moment conservation that motion will tend to be rectilinear is an interesting question, which I discuss in detail in Geoffrey Gorham, "The Metaphysical Roots of Cartesian Physics: The Law of Rectilinear Motion," *Perspectives on Science*, 13 (2005), 431-451. See also Daniel Garber, *Descartes' Metaphysical Physics* (Chicago, 1992), 285-287, and Dennis Des Chene, *Physiologia: Natural Philosophy in Late Aristotelianism and Cartesian Thought* (Ithaca, 1996), 283-286.

4) AT 7 49; CSM 2 33.

5) AT 8A 64; CSM 1 242.

6) AT 11 142: CSM 101; AT 6 84; CSM 1 153. On the distinction between instantaneous motion (which is impossible) and instantaneous actions or transfers of power (which are ubiquitous), see AT 10 402; CSM 1 34.

7) AT 8A 54; CSM 1 233.

So, as Alan Gabbey has observed, "an understanding of Descartes' theory of time would be essential for any adequate account of his mechanics and laws of motion."[8] And yet, as compared with his views on space, motion, and force, Descartes' views on time have received little discussion in recent commentary on his natural philosophy.[9] Perhaps one reason for this neglect is that Descartes' explicit remarks on time are brief and sparsely distributed through numerous published works and letters.[10] A more important reason is that time is treated in his most systematic discussion as somehow reducible both to thought and to motion. Thus, in Part I, Section 57, of the *Principles of Philosophy* Descartes says that time is not a mode or attribute of things, but rather a mere "mode of

8) Alan Gabbey, "Force and Inertia in the Seventeenth Century: Descartes and Newton," in *Descartes: Philosophy, Mathematics and Physics*, ed. Stephen Gaukroger (Sussex, 1980), 303 n40. On the other hand, Alexandre Koyré holds that the "original sin" of Cartesian physics is precisely the elimination of time. (Alexandre Koyré, *Galileo Studies* (Sussex, 1978), 91). Koyré's indictment is based almost entirely on Descartes' early-abandoned efforts to solve the problem of falling bodies, efforts which related acceleration only to the trajectory of the body's path rather than to the time elapsed in the fall—treating the physical problem 'statically', as it were. Notwithstanding Koyré's perceptive analysis of Descartes' struggle with this problem, the moral to be drawn is surely not that time is eliminated from his natural philosophy. For although it is true that Descartes hoped to 'geometrize' motion in order to purge it of scholastic trappings (AT 11 39-40; CSM 1 94), it remains that time and speed are key parameters in the statements or proofs of all the Cartesian laws and collision rules.

9) A notable exception is the question of the alleged discontinuity of Cartesian time, which has been discussed thoroughly and need not be broached here. Good recent discussions include J.-M. Beyssade, *La Philosophie première de Descartes* (Paris, 1979), Martial Guéroult, *Descartes' Philosophy Interpreted According to the Order of Reasons: The Soul and God* (Vol. 1), ed. and trans. Roger Ariew (Chicago, 1984), Garber, *Descartes' Metaphysical Physics*, 266-73, Richard Arthur, "Continuous Creation, Continuous Time: A Refutation of the Alleged Discontinuity of Cartesian Time," *Journal of the History of Philosophy,* 26 (1988), 349-375, J.E.K. Secada, "Descartes on Time and Causality," *The Philosophical Review*, 99 (1990), 45-72, and Ken Levy, "Is Descartes a Temporal Atomist?," *British Journal for the History of Philosophy*, 13 (2005), 627-674.

10) The principal sources are the Third Meditation (AT 7: 48-9, CSM 2 33), Fifth Set of Replies (AT 7 369-370: CSM 2 254-255), *Principles of Philosophy* 1, 48-69 (AT 8A 22-34; CSM 1: 208-217), Conversation with Burman (AT 5 148-149; CSMK: 335), letters to Arnauld (AT 5 193; CSMK 355; AT 5 221-223; CSMK 357-8), and letter to More (AT 5 343; CSMK 373).

thought."[11] In the same section he asserts that time is simply the name we give to the "duration of the greatest and most regular motions which give rise to years and days."[12] As we will see below, reductionistic views of time, which can be traced to Aristotle himself, were common among Descartes' late scholastic contemporaries.[13] However, they are clearly ill-suited to Cartesian physics. Consider, for example, the (second part of the) third law of motion, which states that if a body collides with a weaker body, the stronger loses a quantity of motion equal to what the weaker gains.[14] Suppose the sun were to collide with a smaller celestial object at rest relative to the sun. The third law, in the specific form of the fifth collision rule, implies that the sun would be slowed by an amount equal to the motion it gives to the smaller object.[15] But if time is nothing but the diurnal motion of the sun, then it is *impossible* for the speed of the sun to change. Even more dramatically, if time is a mere 'mode of thought' then physical parameters like speed and quantity of motion must also be somehow mind-dependent. Indeed, it follows that bodies are distinguished from one another only mentally.

It is tempting to dismiss Descartes' apparent reductionism as a sop to his scholastic readers, and so not particularly relevant to his natural philosophy. But in what follows I will attempt to show that, in spite of the apparent identifications with motion and thought, Cartesian time retains—in the form of what I will call 'successive duration'—precisely the intrinsic structure necessary to serve as an independent parameter of quantitative physics. As is often the case with Descartes, he gives the impression of embracing traditional doctrines while in fact radically transforming the underlying concepts to serve his scientific agenda.[16] His

11) AT 8A 27; CSM 212.

12) Ibid.

13) As Ariew and Gabbey observe: "The subjects raised by the scholastics dealt with the subjectivity of time and its intimate connection with motion." (Roger Ariew and Alan Gabbey, "The Scholastic Background," in *The Cambridge History of Seventeenth Century Philosophy*, ed. Daniel Garber and Michael Ayers, 2 vols. (Cambridge, 1998), I: 425-453, 439.

14) AT 8A 65; CSM 1 242.

15) AT 8A 69.

16) Because Descartes hoped that his scientific *magnum opus*, the *Principles of Philosophy*, would replace standard scholastic textbooks (AT 3 276; CSMK 167), he adopted their style of presentation and terminology (AT 7 577: CSM 2 389-390; AT 3 523; CSMK

theory of time, though formulated in Aristotelian terms, anticipates Newton in important respects.

2. Time and the Soul

The account of time in the *Principles* is brief but complex:

> Now some attributes or modes are in the very things of which they are said to be attributes or modes, while others are only in our thought (*in nostra tantum cogitatione*). For example, when time (*tempus*) is distinguished from duration taken in the general sense (*duratione generaliter*) and called the number of movement (*numerum motus*), it is simply a mode of thought (*modus cogitandi*). For the duration which we find to be involved in movement is certainly no different from the duration involved in things which do not move. This is clear from the fact that if there are two bodies moving for one hour, one slowly and the other quickly, we do not reckon the time to be greater in the latter case than in the former, even though the amount of movement may be much greater. But in order to measure the duration of all things (*omnium durationem*), we compare their duration with the greatest and most regular motions, which give rise to years and days, and call this duration 'time' (*hancque durationem tempus vocamus*). Yet nothing is thereby added to duration, taken in its general sense, except a mode of thought.[17]

As already mentioned, this passage contains two surprising claims about time: that it is merely a mode of thought and that it is the name we give to the duration of the most regular celestial motions. Not only are these claims *prima facie* inconsistent, but each in its own way threatens to undermine the function of time as an independent and universal quantitative parameter of Cartesian physics. I will attempt to resolve this problem by examining the two surprising claims in turn, both in purely Cartesian terms and against the background of the late scholastic metaphysics that Descartes aimed to displace.

Notice, first of all, that it is specifically time in the sense of *numerus motus* which Descartes alleges to be merely in our thought. In speaking of time in these terms, he is adverting to Aristotle's famous definition from Book IV of the *Physics*: "time is the number of motion in respect of

210; AT 4 225; CSMK 252). On Descartes' complex relationship with late scholastic philosophy, see Roger Ariew, *Descartes and the Last Scholastics* (Ithaca, 1999).

17) AT 8A 27; CSM 1 212.

before and after."[18] For his part, Aristotle seems to hold that time so conceived would not exist if the soul did not exist: "for if there cannot be someone to count there cannot be anything that can be counted, so that evidently there cannot be number."[19] Some recent commentators have suggested, on the basis of the *Principles* passage above, that Descartes is similarly committed to the mind-dependence of time. For example, Clarence Bonnen and Daniel Flage write:

> Material substance *as such* can have motion as a mode. But since time and duration are only modes of thought, material substance cannot, *as such*, have time or duration as a mode. The conclusion we should draw from *Principles* I, 57 is that a unit of time is an arbitrarily chosen movement used as a standard to which motions are compared to measure their durations. Motions are in matter; both duration and time only help one understand motion.[20]

Bonnen and Flage are not saying merely that the units for measuring time or duration are conventional. Rather this conventionality is the "conclusion we should draw from *Principles* 1, 57," which they take to assert (as premise) that "Time exists 'only in our thought'" and that "duration is a conceptual structure."[21]

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18) Aristotle, *Physics*, 222a 25 in *Basic Works*, ed. Richard McKeon (New York, 1941).

19) Ibid., 223a 23-25. Aristotle goes on to say that that the 'substratum' of time might still exist without souls, "if movement can exist without soul" (223a 27). This might seem to indicate that time can exist without the soul after all, inasmuch as "it is evident that every change and everything that moves is in time" (222b 30-31). But Ursula Coope argues that for Aristotle all change is 'in time', not by virtue of the *nature* or definition of change, but simply because time, change and souls all exist in every conceivable world. It is not of the nature of change or motion to be in time, but it is of the nature of time that it depends on the soul. (Ursula Coope, *Time for Aristotle* (Oxford, 2005), 161-163. For further discussion of the mind-dependence of Aristotelian time, see Julia Annas, "Aristotle, Number and Time," *Philosophical Quarterly*, 25 (1975), 97-113, and Richard Sorabji, *Time, Creation and the Continuum* (London, 1983), 84-97.

20) Clarence Bonnen and Daniel Flage, "Descartes: The Matter of Time," *International Studies in Philosophy*, 32 (2000), 1-11, 5.

21) Bonnen and Flage, "Matter of Time," 6. Other commentators who have interpreted Descartes' conception of time as fundamentally ideal include: Jean-Luc Marion, *On Descartes' Metaphysical Prism* (Chicago, 1999), 181-187; Stephen Gaukroger, *Descartes: An Intellectual Biography* (Oxford, 1995), 368, and *Descartes' System of Natural Philosophy* (Cambridge, 2002), 89; G. J. Whitrow, *The Natural Philosophy of Time* (New York, 1963), 130. In a recent article, Ken Levy maintains that Cartesian time is mind-*in*de-

But there are serious difficulties with such a reading. If Descartes thought that material substances could not have time or duration as a mode or attribute apart from mind then he would also have to hold that they cannot have motion as a mode apart from the mind, since motion presupposes duration. As Descartes says in the *Rules for the Direction of the Mind*, we can no more conceive "a motion wholly lacking in duration" than we can conceive a "shape completely lacking in extension."[22] Indeed, making duration mind-independent would make *everything* mind-dependent since, as I will explain more fully below, Descartes denies any real distinction between existing things and their duration.[23]

So time and duration cannot be mind-dependent for Descartes. Bonnen and Flage run into trouble with *Principles* I, 57 because they fail to appreciate the importance for Descartes of the standard scholastic distinction between *tempus* and *duratio*, which is already flagged in the heading of the section: "What Time and Duration Are." In scholastic authors familiar to Descartes, such as Aquinas and Suarez, *duratio* is simply persistence in being while *tempus* is the measure or numbering of beings that are 'successive' or composed of parts existing one after the other.[24] For example, a human life is temporal because it has first youth,

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pendent in the sense that time does not "emanate from the imagination," but seems to indicate that it may be mind-dependent in the "Kantian" sense that time "is, or depends on, a human construct or intuition" (Levy, "Is Descartes a Temporal Atomist?" 662).

22) AT 10 421; CSM 1 46. See also AT 7 63; CSM 2 44: " ... to the motions I assign various durations." In response to this sort of problem, Bonnen and Flage answer that the passage from the *Rules* "indicates no more than a conceptual connection" between motion and time (Bonnen and Flage, "Matter of Time," 6). But surely the onus is on Bonnen and Flage to show that Descartes thought there could be motion without time (or shape without extension) even though we can't conceive such a thing. In addition, they need to explain why, if he does not think motion absolutely requires duration, Descartes repeatedly insists that there can be no motion in an instant (AT 11 45; CSM 1 97; AT 8A 64; CSM 1 242). For a more detailed defense of the necessity of duration for motion in Descartes see Garber, *Descartes' Metaphysical Physics*, 172-175.

23) AT 8A 30; CSM 1 214-5.

24) St. Thomas Aquinas, *Summa theologica* (hereafter: ST), 1, 10, 1-5 (= First Part, Question 10, Articles 1-5), ed. and trans. Fathers of the Dominican Province, in *Great Books of the Western World*, Vols. 19 and 20 (Chicago, 1953). Francisco Suarez, *Metaphysical Disputations*, 50, 5, 1 (= Disputation 50, Section 5, Sub-section 1) in *Opera omnia,* ed. Carolo Berton (Paris, 1866). For an acute analysis of the relation between the philosophies of time of Suarez and Descartes, see J.-L. Solère, "Descartes et les distinctions

then middle age, and finally old age. In Aristotelian terms, beings in time have a 'before and after'. By contrast, beings like God are 'simultaneously whole' (*toto in simul*) or 'permanent' and called *eternal*. In addition, there is the hybrid, *aeveternal* duration of things like angels and separated souls, which exist successively in accident but not in substance.[25] When Descartes specifies that time (*numerus motus*), as opposed to generic duration (*duratio generaliter*), is a mere mode of thought he means simply that the number or measure, as opposed to the thing numbered, is mind-dependent. For, as he observes, the duration of successive things (whether they are moving or not) is always measured or numbered by comparison with a moving thing (ultimately the sun or some other regular celestial motion). And since comparison is an act of the mind time is a *modus cogitandi*. But this does not imply that *duration* depends on the mind, any more than the current temperature depends on a decision to measure it by the expansion of mercury.

To be more precise, *tempus* is a mode of thought for Descartes because it is generated by an 'abstraction of the intellect'. In the section of the *Principles* immediately following the account of time, Descartes declares that universals are modes of thought "in the same way" as time.[26] For example, the universal *two* is a mere mode of thought, because it results "when number is considered only in the abstract or in general, and not in any created things."[27] In this case, if we look at a pair of objects, "and

médiévales sur le temps," in *Descartes et le Moyen Âge*, ed. J. Biard and R. Rashed (Paris, 1997), 329-348. For detailed discussions of Suarez's philosophy of time, see: Piero Ariotti, "Toward Absolute Time: The Undermining and Refutation of the Aristotelian Conception of Time in the Sixteenth and Seventeenth Centuries," *Annals of Science* 30 (1973), 31-50; Stephen Daniel, "Seventeenth Century Scholastic Treatments of Time," *The Journal of the History of Ideas* 42 (1981), 587-606; Constantino Esposito, "The Concept of Time in the Metaphysics of Suarez," in *The Medieval Concept of Time: Studies on the Scholastic Debate and its Reception in Early Modern Philosophy*, ed. Pasquale Porro (Leiden, 2001), 383-399.

25) For example, angels are permanent in their substantial being but successive in their affections and choices. At least, this is Aquinas' way of explaining aeveternity (see Aquinas, *Summa theologiae*, I, 10, 5). As Porro documents, the concept of aeveternity itself undergoes significant development in the medieval period (Pasquale Porro, "Angelic Measures: *Aevum* and Discrete Time," in *Medieval Concept of Time*, 131-160).

26) AT 8A 27; CSM 1 212.

27) Ibid.

direct our attention not to their nature but simply to the fact that there are two of them," we can generate an idea of *two* and later apply it to other pairs.[28] In the same way, time is an abstraction from the concrete duration of things. We attend to some particular feature of the sun, its regular motion, and exclude its size, color, and so on. We assign to this motion a number, *numerus motus*, expressed in years or days, and extend this number arbitrarily to the duration of other things. We call this universal measure of duration 'time'.[29]

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[28] Ibid. See also AT 7 44-45; CSM 2 30-31; AT 120-21; CSM 2 85-86. Descartes' theory of abstraction is spelled out most fully in a 1642 letter to Gibieuf (AT 3 474-378; CSMK 201-203).

[29] So time is a way of thinking about, i.e. measuring, duration. As Lawrence Nolan has pointed out Descartes frequently uses 'mode of thought' in roughly the sense of *manner of conceiving* or *way of thinking about*, as in 'Plato's forms are a way of thinking about universals' (Lawrence Nolan, "Reductionism and Nominalism in Descartes's Theory of Attributes," *Topoi* 16 (1997), 129-140, 132. See further note 105 below). That Descartes intends *modus cogitandi* in this sense in *Principles* 1, 57 is clearer in the French translation: "Thus time, for example, which we distinguish from duration in general and call the 'number of motion', is nothing but a way in which we think of this duration (*n'est rien qu'une certaine façon dont nous pensons à cette durée*)" (AT 9B 49). What Nolan fails to mention is that among such ways of thinking about things some are subjective and others are objective, depending on whether we consider the thing abstractly or concretely. Number and universals are subjective when they are abstracted from the natures of existing things. My analysis indicates that time is a manner of thinking in this subjective sense. But when not abstracted from existing things number, duration and order are perfectly objective ways of conceiving external things. For so conceived they are not really distinct from the things. In a letter to an unknown correspondent, Descartes says that existence, duration, number and size are called attributes, "because we do indeed understand the essence of a thing in one way in abstraction from whether it exists or not, and in a different way when we consider it as existing; but the thing itself cannot be outside our thought without its existence, or its duration or size, and so on" (AT 4 349; CSMK 280). So there are two manners of conceiving, for example, the essence of a triangle: (i) by a mental abstraction: "we see a figure made of three lines, we form an idea of it which we call the idea of a triangle; and we later make use of it as a universal idea, so as to represent to ourselves all other figures made up of three lines" (AT 8A 28; CSM 1 212); (ii) by considering an objectively existing thing: "the case is not the same with triangle existing outside thought, in which case it seems to me that essence and existence are in no way distinct" (AT 4 350; CSMK 280). As Descartes indicates, duration is what we consider to be inseparable from the thing outside our thought. Because it remains the same just so long as the substance exists, there is a merely a rational distinction between the mode or attribute in question and the substance: "in the case of all the

This conception of time as a mental abstraction from concrete or intrinsic duration is invoked explicitly in one of Descartes' replies to the *Fifth Set of Objections* to the *Meditations*. The author of those objections, Pierre Gassendi, questioned the claim in the Third Meditation that the parts of a lifespan are 'completely independent' of one another: "Can we think of anything whose parts are more inviolably linked and connected?"[30] Gassendi does not explain why the parts of a lifespan are inviolably connected, but that does not prevent Descartes from diagnosing the source of his opponent's confusion. He observes that the alleged connection exists at best only in "parts of time considered in the abstract (*partes temporis in abstracto considerati*)" and not in "the duration of the thing which endures (*durationе rei durantis*)."[31] Although Descartes does not indicate in this context what he means by time in the abstract, my account of *Principles* I, 57 explains why he seems prepared to allow that the parts of time are necessarily connected in a way the parts of concrete duration are not. On my account the abstraction *tempus* involves assigning a number to some periodic motion, such as the diurnal motion of the sun, and extending that number to other things, such as the duration of my life. While there is a necessary connection between the number 40 and the number 41 in the sense that the natural numbers cannot simply end at 40, there is no necessity in my enduring beyond my 40th birthday: "the thing which endures (*rem durantem*) may cease to be at any moment."[32]

When Descartes writes in the *Principles* of "duration taken in the general sense (*durationе generaliter*)," as distinct from time, he is echoing the traditional view that *tempus* is a species of the genus *duratio*. He is not asserting the 'generality' of duration. Rather, as the heading to *Principles* I, 57 indicates, the crucial distinction is between the concrete and the abstract rather than between the particular and the universal: "Some attributes are in things and others are in our thought."[33] So it is not to

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modes of thought which *we consider of as being in objects*, there is merely a conceptual distinction between the modes and the object which they are thought of as applying to" (AT 8A 30; CSM 214. Emphasis added).

30) AT 7 301; CSM 2 209.

31) AT 7 370; CSM 2 255.

32) Ibid.

33) AT 8A 27; CSM 1 212.

the point to contrast concrete duration, on the one hand, with duration in general and time in the abstract, on the other, as Richard Arthur does: "a concrete duration is simply the specific duration of some enduring substance, as opposed to the idea of generic time or duration-in-general. The latter is an ideal concept, formed by abstraction from the durations of all particular things. . ." For in both the *Principles* and the reply to Gassendi Descartes makes it clear that it is *tempus* which is ideal or abstracted, not duration in general (*duratio generaliter*).[34]

3. Time and Motion

We have found that for Descartes time is a mode of thought only in the uncontroversial sense that the numerical measure of 'the duration of all things' depends on a mental process of abstraction.[35] By contrast, and as I will discuss in more detail below, concrete duration is a real attribute of the enduring thing. I would like now to consider Descartes' view of the relation between time and motion. At first glance, the relation seems to be very close: 'time' he says is what we call the duration of "the greatest

[34] Arthur, "Continuous Creation," 361. In the *Principles* and the reply to Gassendi we find a total of four notions: (1) *duratio rei durantis*, which is the concrete duration of a specific substance; (2) *duratio generaliter,* which is concrete duration as genus, not referred to any specific thing; (3) *omnium duratio*, which is the concrete duration of all things considered collectively; (4) *tempus*, which is the measure or number of *omnium duratio*. In both passages, Descartes is at pains to emphasize the abstract, and hence ideal, nature of (4) as compared with (1)-(3). For a good discussion, see Beyssade, *Philosophie première de Descartes,* 131-133.

[35] This is essentially the reading of Spinoza, Descartes' most astute early interpreter: "Duration is distinguished from the whole existence of an object only by reason. For however much of any duration you take away from any thing so much of its existence do you detract from it. In order to determine or measure this we compare this with the duration of those objects which have a fixed and certain motion, and this comparison is called time. Therefore time is not an affect of the thing, but only a mode of thought, or, as we have said, a being of reason; it is a mode of thought serving to explain duration. It should be noted under duration, as it will be of use below when we are discussing eternity, that it is conceived as greater or less, as it were, composed of parts and then not only as the attribute of existence, but the very essence of existence." Benedictus de Spinoza, *The Principles of Descartes' Philosophy*, ed. and trans. Halbert Hains Britan (La Salle, 1974), 130.

and most regular motions, which give rise to years and days."[36] Descartes' scholastic audience would have been very comfortable with this apparent reduction of time to celestial motion. Nevertheless, I will now attempt to show that Descartes breaks decisively with the tradition of 'celestial reductionism'.[37]

This tradition stretches back to Aristotle, who in Book IV of his *Physics* maintains that "time is not independent of movement and change."[38] But neither, he says, is time identical with movement since time is present equally everywhere and not only where a movement occurs.[39] Furthermore, movement is faster or slower but time is not.[40] Rather than motion itself, time is "the number of motion in respect of before and after."[41] As the number of motion, time serves as its measure.[42] And because celestial motion alone is continuous, perfectly regular and eternal, its number serves "above all else" as the measure of motion.[43] There is some question whether Aristotle intends to reduce time to the number of *celestial* motion in particular. In the *Physics* he says time "is simply the number of continuous movement, not any particular kind of it,"[44] but elsewhere that time is the number "of the circular movement."[45] In any event, time for Aristotle is dependent on some regular motion or other. A thing at rest can be in time only indirectly insomuch as "what is at rest can be in the number of motion."[46] Indeed only that which can be moved is 'at rest' strictly speaking;[47] hence, "none of the things which are neither moved nor at rest are in time."[48]

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36) AT 8A 27; CSM 1 212
37) I borrow this label from Ariotti, "Toward Absolute Time."
38) Aristotle, *Physics*, 218b 33.
39) Ibid., 218b 10-12.
40) Ibid., 218b 14-17.
41) Ibid., 219b 1-2.
42) Ibid., 221a 1.
43) Ibid., 223b 19-20.
44) Ibid., 223a 33.
45) Ibid., 337b 25.
46) Ibid., 221b 12.
47) Ibid., 221b 13.
48) 221b 22. For detailed discussion, see Coope, *Time for Aristotle*, ch. 2.

In medieval thought, the association between time and motion becomes, if anything, closer.[49] Aquinas accepted Aristotle's definition of time and with it the implication that there is no time without motion since "in a thing bereft of movement, which is always the same, there is no before or after."[50] Furthermore, he understood Aristotle's theory to require that time is a function only of the motion of the outermost sphere ('the first motion'). Thus, he takes Aristotle's point about time not being faster or slower to indicate precisely that "time is consequent upon the quantity of only the first motion."[51] Through the influence of Aristotle and Aquinas celestial reductionism remained the dominant scholastic view into the seventeenth century. For example, Suarez holds that "since *tempus* is the duration of motion it is not really distinct from motion, but only conceptually distinct."[52] Furthermore, "absolutely speaking, even the motion of the inferior celestial spheres is measured by the first motion (*motu primi mobilis*) which in turn is, simply speaking, time."[53]

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[49] So close was the relation between time and celestial motion in scholastic metaphysics that, according to Duhem, Robertus Anglicus was far from alone in asserting that "if the first heaven were to stop rotating, a falling stone would stop falling." (Pierre Duhem, *Theories of Infinity, Place, Time, Void and the Plurality of Worlds*, ed. and trans. Roger Ariew (Chicago, 1985), 297).

[50] *Summa theologiae*, 1, 10, 1.

[51] St. Thomas Aquinas, *Commentary on the Physics of Aristotle*, trans. Richard Blackwell, Richard Spath and Edmund Thirkel (New Haven, 1963), 576.

[52] Suarez, *Metaphysical Disputations*, 50, 9, 1. Similar conceptions of the relation between motion and time can be found in other late scholastic authors known to Descartes, such as Eustachius à Sancto Paulo and the Coimbra Commentators. See Eustachius: "tempus internum ne differat realiter a motu," *Summa philosophiae quadripartita,* Part I (*Physica*), treatise 3, disputation 3, question 2 (Paris, 1640), 159; Coimbra Commentators: "tempus non distingui re a motu," *Commentarii Collegii Conimbrincensis,* IV (*Physicorum*), question. 2, article 2 (Coimbra, 1602).

[53] Suarez, *Metaphysical Disputations*, 50, 11, 5. See also 50, 10, 11. Although I think Sarah Hutton is right that "the central doctrine in the scholastic view was that time is inextricable from motion" (Sarah Hutton, "Some Renaissance Critiques of Aristotle's Theory of Time," *Annals of Science* 34 (1977), 344-363, 350), I do not mean to suggest that the seventeenth-century scholastic accounts are crudely reductionistic. Thus, Suarez develops a distinction between 'extrinsic time' and 'intrinsic time', which foreshadows Descartes' distinction between abstract time and concrete duration. Extrinsic time is the single universal measure of duration, by convention the motions of the heavens. Intrinsic time is the successive existence of individual movements. Unlike in Descartes, however, both sorts of time are inextricably tied to motion, whence Suarez's conclusion that

Reductionism persists outside the schools as well, even in astronomers working to displace Aristotelian cosmology. Thus, in the *Letter against Werner*, Copernicus endorses the familiar formula that "time is the number of the motion of the heavens considered as before and after" and goes on to indicate that he does not regard time as distinct from the heavenly motions: "the measure and the measurer, being related, are interchangeable."[54]

Yet speculation about the possibility of unchanging or 'empty' time increased in late scholasticism, even if its actual existence was ruled out. For example, Duns Scotus held that even if all movement in the universe were to cease, "still to this uniform immobile existence there corresponds a proper measure, which is time."[55] But Scotus concedes that this empty time "would not be actual and positive, but merely potential and privative" and so only "quasi-temporal."[56] Similarly, Suarez and others entertained an 'imaginary time' by which one can conceive the motions that might have occurred before creation or beyond the outermost sphere.[57] But these authors emphasize that imaginary time, while not a mere figment of the imagination, is nevertheless only a conceptual tool, an *ens rationis* rather than a really existing duration.[58]

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there are as many intrinsic times as distinct movements (*Metaphysical Disputations*, 50, 10, 11). For discussion see Daniel, "Seventeenth Century Scholastic Treatments of Time." I thank Jorge Secada for guidance on the subtlety of Suarez's treatment.

54) Nicholas Copernicus, *Letter against Werner*, in *Three Copernican Treatises*, ed. Edward Rosen (New York, 1971), 97. For more detailed discussions of celestial reductionism, and its challengers, in the late medieval and early modern periods, see Ariotti, "Toward Absolute Time" and Sutton, "Some Renaissance Critiques."

55) John Duns Scotus, *Quodlibetal Questions*, question 11, article 2, in *God and His Creatures: The Quodlibetal Questions*, ed. Felix Alluntis and Allan B. Wolter (Princeton, 1975), 263.

56) Ibid. For discussion of Scotus' concept of time see Duhem, *Theories*, 295-299, Olivier Boulnois, "Du temps cosmique à la durée ontologique? Duns Scot, le temps, l'aevum et l'éternité" in *Medieval Concept of Time*, 161-188 and Richard Cross, *The Physics of Duns Scotus* (Oxford,1998), Ch. 12.

57) Suarez, *Metaphysical Disputations*, 50, 9, 15. See also *Coimbra Commentaries*, *Physics*, IV, question 1, article 2; Eustachius, *Physica*, part I, treatise 3, disputation. 3, question 2.

58) See, for example, *Metaphysical Disputations*, 54, 4, 7. See also Suarez, *Commentary on the Metaphysics*, Bk. XII, ch. 6, question 1, ed. and trans. John P. Doyle (Milwaukee, 2004), 209. In a letter to More, Descartes dismisses the corresponding notion of an imaginary void space surrounding real space: "I think it involves a contradiction to sup-

The most significant early avowals of empty time were by Renaissance opponents of Aristotle, such as Bernardino Telesio and Giordano Bruno. The fact that we always perceive motion and duration together, Telesio argues, "is no reason for claiming that one of them is the essence of the other."[59] In the standard scholastic treatments, duration has almost no independent structure, and acquires attributes like successiveness and quantity only in movement (at least in the case of material things).[60] Against this conception, Telesio dismisses the assumption that "continuity and succession inhere in quantity, and through quantity also in motion" and asserts instead that "time exists by itself and in no way depends on motion; whatever characteristics it has, it has them all from itself and none from motion."[61] He says little about the intrinsic struc-

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pose that the universe is finite or bounded because I cannot but conceive a space beyond whatever bounds you assign to the universe; and on my view such a space is a genuine body. I don't care if others call this space imaginary and thus regard the world as finite." (AT 5 345; CSMK 374-375). But in a letter to his friend Chanut it evidently occurs to Descartes that his argument for making the universe indefinitely spatially extended threatened to make it also indefinitely temporally extended into the past. He cautiously admits: "there is no imaginable time before the creation of the world in which God could not have created it had he so willed" (AT V 53; CSMK 320), and seems to leave the door open to imaginary time: "the actual or real existence of the world during these last five or six thousand years is not necessarily connected with the possible or imaginary existence which it might have had before then in the way that the actual existence of the spaces conceived as surrounding a globe are (i.e. surrounding the world as supposed finite) is connected with the actual existence of the globe" (ibid.). They are not connected in the same way, because although any boundary on the space of the universe implies more actual space beyond it, this is not so for time because "every moment of its [the world's] duration is independent of every other." (Ibid.) So imaginary time cannot be dispensed with on the same philosophical grounds as imaginary space. Of course, to admit infinite "possible or imaginary" time is not to admit that the university is actually created from eternity, which is ruled by faith alone. Thus the following from Descartes' personal notes on the *Principles*: "we must not fear that in philosophizing about the indefinite extension of the world we should find its duration also mounting to infinity. For we do not hold that the extension of the world is infinite, or that its duration backwards in time is indefinite: this is, from the point of view of natural reason, definitely not possible since the fact that creation has a beginning is perfectly settled" (AT 11 656).

59) Bernardino Telesio, *De rerum natura*, book. I, section 29 (Hildesheim, 1971), 43. Also in Milič Čapek, *The Concepts of Space and Time* (Dordrecht, 1976), 187-8.

60) See, for example, Suarez, *Metaphysical Disputations*, 50, 8, 4.

61) Telesio, *De rerum natura*, 44. Also in Čapek, *Concepts of Space and Time*, 188.

ture of time (except that it "flows"), but is clear that this structure is not derivative from motion: "time is the interval, duration and extent, not over which (*super quo*) or through which (*per quod*), but in which (*in quo*) all motion and change occur."[62] Similarly, Bruno insists that if were there no motion things would nevertheless "all endure by one and the same duration."[63] However this duration, which he calls *eternity without beginning or end*, is not successive in its own right and so cannot serve as a common standard for diverse motions. Rather, each motion has its own time measure unrelated to eternity: "time is understood as flowing most rapidly in those things which move very fast, and at a slower rate in things which change more slowly."[64] So although neither is prepared to endow intrinsic duration with the full structure of *numerus motus*, Telesio and Bruno both grant natural things a recognizably temporal kind of duration quite apart from motion.[65]

Descartes might seem to be with Aristotle and the celestial reductionists, against the proponents of empty time, since he says that *tempus* refers to the duration of "the greatest and most regular motions."[66] However, it is clear that time in this sense is simply a convention we adopt "in order to measure the duration of all things."[67] Owing to their regularity, continuity, and accessibility, such motions provide a convenient numerical gauge of duration generally. As discussed above, this is why Descartes says that when we compare the regular motions to the duration of all

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62) Ibid. Similarly, Telesio's follower, Tommaso Campanella, defined time independently of motion, in terms of the 'successive duration' in things. See Paolo Ponzio, "*Tempus, Aevum, Aeternitas* in Tommaso Campanella," in *Medieval Concept of Time*, 507-518.

63) Giordano Bruno, *Camoeracensis Acrotismus*, article 40, quoted in *The Concepts of Space and Time*, 192. For discussion of Bruno on time, see Hutton, "Some Renaissance Critiques" and Miguel Granada, "The Concept of Time in Giordano Bruno: Cosmic Times and Eternity," in *Medieval Concept of Time*, 477-506.

64) Bruno, *Camoeracensis Acrotismus*, art. 39, in *Concepts of Space and Time*, 191. On the lack of succession in Bruno's universal duration, see Granada, "The Concept of Time in Giordano Bruno," 505.

65) Descartes himself seems to have been familiar with the writings of Telesio and Bruno, as well as Campanella, as he indicates in a 1630 letter to Beeckman (AT 1 158; CSMK 27). He would also likely have known Scotist doctrines, at least indirectly, from various late scholastic sources. See further Ariew, *Descartes and the Last Scholastics*, ch. 2.

66) AT 8A 27; CSM 1 212.

67) Ibid. This is a point emphasized by Bonnen and Flage, "The Matter of Time," 5.

things, nothing is added to generic duration "except a mode of thought."[68] Thus, Descartes' apparent celestial reductionism applies to *tempus*, which is a mental abstraction, rather that to concrete or generic duration. Time, in the form of hours and days, is to duration as miles and feet are to extension in one dimension. So although he agrees with the Aristotelians that if there were no motion there would be no time, he does not agree there would be no duration: "the duration which we find to be involved in movement is certainly no different from the duration involved in things which do not move."[69] On this crucial point, he is with Telesio and Bruno. In fact, as I shall now explain, he goes further than either of these philosophers in the amount of intrinsic structure he gives concrete duration independently of *numerus motus*.

Descartes accepts the standard definition of time as the measure of successive duration. But he rejects the traditional view that duration is successive only in relation to motion and change. Rather, concrete duration is successive by nature, with parts arranged in a fixed order, regardless of motion or thought. And so, unlike Aquinas and Suarez, Descartes does not admit various species of duration—eternity, aeveternity and time—for various things according to the degree of their involvement in change and succession. Rather all things that exist, whether movable or not, created or not, material or thinking, endure successively.

Consider my own duration, i.e. the duration of my soul. In the Third Meditation, Descartes insists that my lifespan "can be divided into countless parts (*partes innumeras dividi*), each completely independent of the others."[70] Like the parts of bodily extension, the parts of my duration cannot overlap—they "never exist simultaneously (*nec unquam simul existent*)," as he observes in the *Principles*.[71] Although he says the successiveness of my lifespan follows from the "nature of time (*partes temporis naturam*)" it is clear that he means the nature of concrete duration rather than abstract time, as he makes explicit in the response to

68) AT 8A 27; CSM 1 212.

69) Ibid. According to Solère, Descartes' attribution of successive duration all created substances, whether moving or not, is what most crucially distinguishes his conception of time from that of the Suarez (Solère, "Descartes et les distinctions médiévales sur le temps," 337).

70) AT 7 49; CSM 2 33.

71) AT 8A 13; CSM 1 200.

Gassendi discussed above: "You try to evade my arguments by talking of the necessary connection which exists between the parts of time considered in the abstract (*partes temporis in abstracto considerati*); but this is not the issue: rather we are considering the time or duration of the thing which endures (*durationе rei durantis*)."[72] The duration of bodies is also successive in itself: "The separate divisions of time do not depend on one another. Hence the fact that the body in question is supposed to have existed up until now. . . is not sufficient to make it continue to exist in the future."[73] Enduring bodies, like minds, have parts which exist one after another, without regard to any extrinsic measure.

There is additional evidence that substances in the Cartesian world have temporal stages arranged in a fixed order. In response to an objection from Arnauld that God could not be his own cause, since he would then be prior to himself, Descartes answered that causes are not temporally prior to their effects.[74] This response would be otiose if there were no fact of the matter concerning the sequence of states of enduring things. Consider also this rather surprising declaration at the beginning of the Third Meditation (after the *cogito*, but before the first proof of God): "Let whosoever can deceive me, he can never bring it about that I am nothing so long as I continue to think I am something; *or ever make it true that I have never existed since it is now true that I exist*."[75] If the order of duration were not absolutely fixed, then a malicious counterpart of God could easily bring it about that I never existed, perhaps by making tomorrow the day of my parents' first encounter.[76]

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72) AT 7 369-370; CSM 255. This is also clear in the *Principles* version of the argument, where Descartes says it follows that my lifespan has parts from "time or the nature of enduring things (*temporis sive rerum durationis naturam*)" (AT 8A 13; CSM 1 200).

73) AT 7 110; CSM 2 79.

74) AT 7 108; CSM 2 78.

75) AT 7 36; CSM 2 25; emphasis added.

76) Viewed in this way the impossibility of making it the case that I never existed is a special instance of the common notion that *what is done cannot be undone* (AT 8A 24; CSM 1 209. See also AT 7 82; CSM 2 57). In a recent discussion of the Third Meditation passage, Brian Kirby suggests that Descartes must have considered it only a psychological or conceptual impossibility for God to make me never to have existed since "on the supposition that the moments of time are discrete and independent, it would seem that God could have established any order He wished for them" (Kirby, "Descartes, Contradiction and Time," *History of Philosophy Quarterly*, 10 (1993), 137-145, 139). But

In a 1648 exchange of letters, Antoine Arnauld presents Descartes with an opportunity to qualify his position on the essential successiveness of duration. Arnauld asks whether Descartes seriously wants to hold that the duration of the mind is successive given that "the Philosophers and Theologians" commonly assert that its duration is "permanent and all at once (*permanentem & totam simul*)."[77] Perhaps, Arnauld suggests, Descartes was referring to the duration of motion, "which alone is time in the strict sense (*sola proprie tempus est*)."[78] Descartes answers that the view of the Philosophers and Theologians "rests on the scholastic opinion with which I strongly disagree, that the duration of motion is of a different nature from the duration of things which are motionless."[79] This, he notes, was already explained in *Principles* I, 57: "the duration which we find to be involved in movement is certainly no different than the duration involved in things which do not move."[80] He goes on to say that the human soul would endure successively even if there were no bodies. In a follow-up letter Arnauld presses Descartes on the difficulty of understanding how a motionless thing can endure successively. But Descartes' reply is firm: "I do not understand the successive duration (*durationem successivam*) of things that move, or even of motion itself, differently from things that do not move."[81] So the duration of all beings has the same successive nature even if the being is a mind and not at all subject to motion.

If this is right then it should follow that, for Descartes, even God endures successively. As the continuous sustainer of matter and motion,

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although it is true that for Descartes the parts of my duration are *independent* (he does not say they are *discrete*), it does not follow from this that they can be re-arranged. It may be that relative positions in time are fixed in the way relative positions in space are: if part of time A is earlier than B it cannot be made later and still be the same time, just as if region of space A is west of B it cannot be made east and remain the same space. Despite this, the times and spaces could remain independent in the sense that no part explains the existence of any other part. For further discussion of this issue, see Gorham, "Cartesian Causation: Continuous, Instantaneous, Overdetermined," *Journal of the History of Philosophy*, 42 (2004), 389-423.

77) AT 5 188.

78) Ibid.

79) AT 5 193; CSMK 355.

80) AT 8A 27; CSM 1 212.

81) AT 5 223; CSMK 358.

God's operation does seem to have a temporal order beginning with the original creation and persisting immutably ever after: "God imparted various motions to the parts of matter when he first created them, and he now preserves all this matter in the same way, and by the same process as when he originally created it."[82] From this unchanging operation Descartes derives his laws of motion. In the case of one of these, the law of rectilinear motion, the derivation seems especially to involve successive action on the part of God. Descartes says God "always conserves the motion in the precise form in which it is occurring at the very moment when he conserves it, without taking account of the motion which was occurring a little while earlier."[83] This suggests that God's creative action is successive, since it is always directed at the present moment to the exclusion of earlier ones. Yet in the same work (*Principles of Philosophy*) he seems to indicate that God's action is absolutely undivided: "there is always a single identical and perfectly simple act by means of which he simultaneously understands, wills and accomplishes everything."[84] It may be possible to reconcile these claims. One might hold, for example, that God's actions are simple and unified only at any given time.[85]

But however this problem is resolved, it may be that God's duration is all at once even if his actions are successive. Unfortunately, we know of only two occasions on which Descartes comments specifically on God's duration. Moreover, neither text is in a published work, and they seem to express conflicting opinions. In the first of the two 1648 letters to Arnauld just discussed, Descartes seems to endorse the orthodox conception of God's duration as permanent: "even if no bodies existed, it could still not be said that that the duration of the human mind was

82) AT 8A 62: CSM 1 240. See also *le Monde*, where Descartes says "with God always (*toujours*) acting in the same way, and consequently always producing substantially the same effect, there are, as if by accident, many differences in the effect" (AT 11 37-38; CSM 1 93).

83) AT 8A 63-4; CSM I 242. See also the version of the proof in *le Monde*: "God conserves each thing by an uninterrupted action, and consequently he conserves it not as it might have been at some earlier time but precisely as it at the very instant he conserves it" (AT 11 44; CSM 1 96).

84) AT 8A 14; CSM 1 201.

85) Or one might hold, with Richard Arthur, that God's creative action "while unextended and divisible with respect to its nature, is nonetheless extended and divisible with respect to its duration" (Arthur, "Continuous Creation, Continuous Time," 359).

entirely simultaneous (*tota simul*) like the duration of God; for our thoughts manifest a succession which cannot be found in the divine thoughts."[86] But in the only other discussion of God's duration, which is more direct and detailed, he seems to take the opposite position. In the course of a 1648 interview with Burman Descartes reiterates his view that human thought is "extended and divisible with respect to its duration" and goes on to say: "It is just the same with God: we can divide his duration into an infinite number of parts, even though God himself is not therefore divisible."[87] When Burman objected in his follow-up that divine eternity is "all at once and all together (*simul et semel*)," Descartes replied dismissively: "That is inconceivable (*hoc concipi non potest*)."[88] He then elaborates on the sort of eternity that, in his view, God *does* possess:

> It is true that it is all at once in so much as nothing can be added to or subtracted from God's nature. But it is not all at once in the sense of existing simultaneously (*simul existit*). Since we can distinguish among its parts after the creation of the world, why shouldn't it have been possible to do the same before creation, since the duration is the same (*cum eadem duratio sit*)?[89]

In this passage, Descartes explicitly repudiates the classical conception of God's eternity as 'simultaneously whole' and substitutes for it a conception, compatible with successive duration, grounded on the immutability of God's nature. This alternative conception of eternity as essential immutability is invoked elsewhere by Descartes in connection with geometrical essences: "since they remain always the same (*eadem semper*), it is right to call them immutable and eternal (*immutabiles & aeternae*)."[90] His argument against the classical model of eternity is based on a claim about duration first made in the *Principles* and then repeated in the letters to Arnauld: duration is the same whether or not it is related to something moving or even movable. Since God's duration is clearly successive now, it is successive always.

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86) AT 5 195; CSMK 355.
87) AT 5 149; CSMK 335.
88) AT 5 148.
89) AT 5 149.
90) AT 7 381; CSM 2 262.

As evidence of Descartes' settled opinion about God's duration, which of the two documents, the letter to Arnauld or the record of Burman's interview, carries more weight? On the one hand, it is not surprising that Descartes would decline to contradict Arnauld's orthodox, non-successive conception of God's duration, which Arnauld declares "certain"[91] in his letter and for which he elsewhere invokes no less an authority than St. Augustine.[92] Descartes' primary aim in the exchange with Arnauld is to reinforce the point that our own minds endure successively, which is crucial for the Third Meditation proof of continuous creation. As usual, he wants to avoid purely theological disputes, so he simply indicates to Arnauld that insofar as God's duration is indeed 'all at once', whether in the traditional sense of *tota simul* or in Descartes' revised sense of essential immutability, then our duration isn't like his. On the other hand, it is impossible to verify the more detailed remarks to Burman since their transcription was not checked by Descartes himself. Nevertheless, these remarks bring together, reiterate, and elaborate a number of themes that run through Descartes' scattered discussions of time—the distinction between duration and its measure, the identity of duration in the moved and unmoved, the divisibility of created endurance into parts, the model of eternity as essential immutability—and this strongly supports their authenticity on this score.[93]

I have interpreted Descartes' views about time and duration as furthering the move away from celestial reductionism, a move that begins in Duns Scotus, or perhaps even Bonaventure.[94] More than Scotus and the

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91) AT 5 188.

92) AT 7 211; CSM 2 148-149.

93) For an opposing reading of these texts, see Tad Schmaltz, *Radical Cartesianism: The French Reception of Descartes* (Cambridge, 2002), 200-201. Schmaltz's book includes an interesting discussion of the views of the French Cartesians Pierre-Sylvain Regis and Robert Desgabets on the inter-relations among time, motion and the mind. As Schmaltz shows, their views involve a partial return to the Aristotelian position.

94) To the duration of angels, i.e. the *aevum*, Bonaventure attributed succession independent of motion and change. See Pasquale Porro, "Angelic Measures: *Aevum* and Discrete Time," in *Medieval Concept of Time*, 131-160. Armogathe considers this a precursor to Cartesian time, while Porro sees in it "the first uncertain steps taken in the Middle Ages towards the idea of an absolute time" (J.-P. Armogathe, "Les sources scolastiques du temps cartésien: Éléments d'un débat," *Revue Internationale de Philosophie*, 37 (1983), 326-336, 159.

later scholastics were prepared to do, the Renaissance philosophers Telesio and Bruno firmly separate time from motion and thought. As Telesio says, "whatever characteristics it has, it has them all from itself."[95] However, the independent time of these philosophers does not retain the successive structure of *numerus motus*. As a consequence, as I have noted, Bruno does not relate particular motions to the universal time, but is forced instead to admit that time is faster or slower depending on this or that motion. But Descartes not only distributes duration uniformly through all things, movable or not, he also endows it with all the successiveness of periodic motion. As a result he avoids relativizing time (and speed) to particular motions: "For the duration which we find to be involved in movement is certainly no different from the duration to be found in things which do not move. This is clear from the fact that if there are two bodies moving for an hour, one slowly and one quickly, we do not reckon the amount of time to be greater in the former than in the latter, even thought the amount of movement may be much greater."[96] In Descartes' system, concrete duration is a fixed order of before and after which pervades all being, while time is simply a convenient numbering of this succession.[97]

Descartes' view may thus be compared with the anticipations of Newtonian absolute time found in seventeenth-century figures like Gassendi and Isaac Barrow. For Gassendi, not only is time a thing independent of all change, it is also composed of successive parts: "for whatever time is, it elapses, and has its before and after, whether it is measured or not."[98] Like Descartes, he draws from this the conclusion that all measured times are relative only to concrete duration rather than to motion. If the

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95) Telesio, *De rerum natura*, 44. Also in *Concepts of Space and Time,* 187.

96) AT 8A 22; CSM 1 212.

97) In the *Rules for the Direction of the Mind,* Descartes ranks duration (along with existence and unity) among those simple natures common to both thinking and material things (AT 10 419; CSM 1 45). In the *Meditations* he includes among the "simple and universal things" the "time through which things endure" (AT 7 20; CSM 2 14). It is worth mentioning that the French translation of this last passage is "the time which measures their duration [*le temps qui mesure leur durée*]" (AT 9A 15), which perhaps indicates that Descartes wanted to emphasize that it is duration rather than time which really pertains to objects.

98) Pierre Gassendi, *Syntagma philosophicum, Physicae*, section I, book 2, in *Selected Works of Pierre Gassendi*, ed. and trans. Craig B. Brush (New York, 1972), 393.

sun were to move twice as fast, "time would not therefore be twice as fast, but rather the space of two days would be equal to the space of one of those that we have now."[99] Newton's teacher, Isaac Barrow, says that time, "which does not imply motion as far as its absolute and intrinsic nature is concerned," has the structure of a line: "for time has length alone, is similar in all its parts, and can be looked upon as constituted from simple addition of successive instants."[100] As such, time brings diverse motions under a common measure: "we compare motions with one another by the use of time as an intermediary."[101]

But there remains an important difference between Descartes and these 'proto-Newtonians' (not to mention Newton himself), on the nature of time. For Gassendi, time is "something incorporeal which is understood to exist by itself" so that "even before there were any things time flowed."[102] For Barrow also, "time existed before the world began," though he considers this "not an actual existence, but only the possibility or capacity of continuation of existence."[103] But Descartes will have nothing to do with subsistent duration apart from enduring things: "I think it involves a contradiction to conceive of any duration intervening between the destruction of an earlier world and the creation of a new one."[104] While the duration of a thing is independent of motion and change, it is only conceptually distinct from the thing itself: "since a substance cannot cease to endure without also ceasing to be, the distinction

99) Ibid., 396.

100) Isaac Barrow, *Geometrical Lectures*, Lecture I, trans. J. M. Child (London, 1916), 35, 37.

101) *Geometrical Lectures*, 37. For detailed discussion of Barrow's conception of time, especially in relation to Newton's, see Mordechai Feingold, "Newton, Leibniz, and Barrow Too: An Attempt at a Reinterpretation," *Isis*, 84 (1993), 310-338, and Richard Arthur, "Newton's Fluxions and Equably Flowing Time," *Studies in the History and Philosophy of Science*, 28 (1995), 323-351.

102) Gassendi, *Syntagma philosophicum, Physicae*, section I, book 2, in *Concepts of Space and Time,* 195. See also AT 7 301; CSM 2 209.

103) Isaac Barrow, *Geometrical Lectures*, 35.

104) AT 5 343; CSMK 373. Note that Descartes' point here is not that *God* would not endure between the worlds since God, no less than finite things, "cannot cease to endure without ceasing to be" (AT 8A 39; CSM 1 214). Indeed, as discussed above, Descartes says God's duration is "the same" before and after the creation of the world (AT 5 149). His point rather is that although duration can exist apart from motion and change, it cannot exist absolutely on its own, in the manner of a substance.

between a substance and its duration is merely a conceptual one."[105] In general, a substance and one of its attributes are merely conceptually distinct when "we are unable to form a clear and distinct idea of the substance if we exclude from it the attribute in question."[106] For example, the extension of a body is merely conceptually distinct from the body itself.[107] But granted we cannot conceive of a body without extension, or a substance without duration, why is the converse not conceivable in each case? Descartes' answer in the case of body is: "it is a complete contradiction that a particular extension should belong to nothing."[108] Likewise, it would involve a "contradiction," as he says to More, to conceive the attribute of duration belonging to nothing. For Descartes, duration is not a container through which things persist, anymore than space is a container through which things extend.[109]

4. Conclusion

According to Descartes, time is a mere mode of thought because it is the mind's imposition of a conventional measure, abstracted from the regu-

105) AT 8A 30; CSM 1 214. See also AT 4 349; CSMK 280; AT 3 665; CSMK 218; AT 7 44-45; CSM 2 30-31. This explains what Descartes intends when he says "we should regard the duration of a thing as simply a mode under which we conceive the thing insofar as it perseveres (*perseverat*)" (AT 8A 26; CSM 1 211. See also AT 8A 30: CSM 1 214). He does not mean that duration is a mode of our thought in the sense of being a modification or quality of thinking substance, as he proceeds to make clear: "in the case of created things, what always remains unmodified—for example, existence or duration in a thing which exists and endures—should not be called a quality or mode but an attribute," where an attribute is simply a general way in which a substance exists (AT 8A 26; CSM 1 211-212; see further note 29 above).

106) Ibid. This is also Suarez's view (*Metaphysical Disputations*, 50, 1, 5). On the other hand, Aquinas says that "no other being [than God] is its own duration" (*Summa theologiae*, I, 10, 3).

107) AT 9B 53.

108) AT 8A 49; CSM 1 230. Again: "As I have often said, nothingness cannot possess any extension" (AT 8A 50; CSM 1 231).

109) The importance of Descartes' identification of substance and duration for understanding his theory of time has been noted by a number of commentators, including Arthur, "Continuous Creation, Continuous Time," 356-357, Garber, *Descartes' Metaphysical Physics*, 174-5, 272-3, and Solère, "Descartes et les distinctions médiévales sur le temps," 33.

lar motions of the heavens, upon generic duration. Yet all things, mobile and immobile, mental and physical, substance and mode, creator and created, endure in a successive manner, independently of such measures, so long as they exist. There is no risk of idealizing Cartesian physics, or relativizing the laws of motion to a particular celestial measure, if duration is successive and remains constant. For the laws can all be understood in terms of successive duration rather than *tempus*. Consider, for example, the fundamental principle of the conservation of quantity of motion which, according to Descartes, implies that "if one part of matter slows down, we must suppose that some part of matter of equal size speeds up by the same amount."[110] Take the simplest case of a collision in which one perfectly solid body stops moving and another of equal size and solidity starts moving. Even though time is a "mode of thought," the principle does not say that some mind measures the two bodies as trading their speeds relative to the motion of the sun. It says they trade their speeds relative to the surrounding plenum and the successive duration of all things. And were the sun to collide with a satellite, it would slow down in accord with the third law of motion, even if the sun itself were our only measure of such changes. The successive duration of its motion is absolute even if its measure is conventional and approximate.[111] Descartes himself makes this point about the difference between speed as a real mode and as a measure in the *Rules for the Direction of the*

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110) AT 8A 36; CSM 1 240.

111) Several of Descartes' laws and collision rules—such as the first law, which implies that if a body is in motion "there is no reason to think it will lose any of this motion of its own accord" (AT 8A 62; CSM 1 241)—seem to involve absolute (non-relational) conceptions of motion and speed. The notion of concrete successive duration that I am attributing to Descartes allows absolute speed, but not without the addition of absolute space. For example, in the case just given, if space is purely relational, then we can just as well regard the first body as originally at rest and later moving. The problem is that Descartes himself seems to have a relational concept of space, or at least motion. This leads to serious problems for Cartesian physics, several of which Newton catalogued (Isaac Newton, *De gravitatione et aequipondio fluidorum*, in *Unpublished Papers of Isaac Newton*, ed. A. Rupert Hall and Marie Boas Hall (Cambridge, 1962), 123-131). For detailed discussion of the problem of relationism vs. absolutism in 'Cartesian spacetime', see Garber, *Descartes' Metaphysical Physics*, and Edward Slowik, *Cartesian Spacetime* (Dordrecht, 2002). For my purposes, it is sufficient to observe that Descartes has some notion of speed, even if it is only relative speed, i.e. the rate at which bodies change relative posi-

Mind. He defines "dimension" as a mode in respect of which something is considered to be measurable and says that speed is the dimension of motion. He then says that some dimensions are "arbitrary inventions of the mind" while others have a real basis: "the weight of a body is something real; so too is the speed of a motion . . . but the division of the day into hours or minutes is not."[112]

Besides clarifying the notions of time and duration in Descartes' thought, I hope this discussion has also provided some indication of the place of Descartes' philosophy of time in the early modern history of that subject. If my account is correct, then Descartes gives all duration a successive structure, something philosophers had previously reserved only for beings that exist in relation to motion and change. While he retains the Aristotelian view of time as dependent on change, his notion of *tempus* is so deflated that this dependence has no significant implications for his natural philosophy. Rather, the important physical and metaphysical questions concern concrete duration, which Descartes endows with genuine succession and spreads evenly through all existence (even God). In effect, he collapses the time-honored tripartite distinction among duration, time, and eternity. Certainly he does not go so far as to make duration an entity apart from enduring things, as Gassendi and Newton did. Descartes would consider that a mistake analogous to making space a thing distinct from bodies. However, like order and number, duration is one of those most general notions "which extends to all classes of things."[113] And, again like order and number, successive duration is essential to understanding the world in terms of mathematical physics.[114]

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tion. If two bodies change relative position, the intrinsic successive duration of that process will be the same whether their respective speeds are absolute or merely relative.

112) AT 10 448; CSM 1 63. Similar remarks apply to other temporal notions in Cartesian physics. Thus, when Descartes says in the *Optics* that "light can extend its rays instantaneously from the sun to us" (AT 6 84; CSM 1 153), he does not mean that the "actions" of the ray at the sun and upon the eye are observed both to occur when the sun is at a certain point in the heavens. Rather, he means that the actions of the ray at the sun and upon the eye co-exist, however fleetingly.

113) AT 8A 23; CSM 1 208.

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