Descartes’Science, Holism, and the Mechanical Philosophy

Abstract (Word Count:100)

In recent treatments of “holism”in the history of science, Descartes’ natural philosophy is oftenjudged to be a paradigm instance of a “mechanistic” andreductivist scientific approach. This essay, on the contrary, will challenge this view byexploring various aspects of Descartes’ conservation principle for thequantity of motion (size times speed), especially its largely neglectedfunction as a measure of both durational motion and instantaneous "tendencies towards motion". Despite theprevailing consensus, it will be demonstrated that an underlying non−local, or holistic, elementis essential to a full understanding of the conservation principle’sdevelopment and intended operation.

Descartes' Science, Holism, and theMechanical Philosophy

(Total Word Count: 4879)

There are a significant number of contemporaryscholars, possibly the majority, who accuse Descartes of having saddled theWestern scientific tradition with a crass form of reductionism andmechanism. This "mechanistic" bias, according to some commentators, has played a major causalrole in the rise of various negative social, political, and environmentaleffects, such as our present−day concerns over Western social/political imperialism, environmental exploitation, and race/genderdiscrimination. While some studies have been content to merely note thealleged mechanistic features of the Cartesian system (e.g., traditionalanalytic−based examinations, like Grosholz 1991), a number of postmodern, or gender, critics have proceeded tocontrast their perception of Descartes' science with a variety of non−mechanistic alternatives which, theybelieve, are less prone to the social and environmental disadvantages listed above (Bordo 1987, chap.1; Merchant 1980, chap. 9; Easlea, chap. 3; toname only a few). Implicit in all of their arguments, of course, is thebasic assumption that Descartes' science is "mechanistic"; which further presupposes, more problematically, that some agreement canbe reached on what exactly constitutes the mechanical philosophy.

Contrary to this prevailing consensus, this essay willargue that the nature and classification of Descartes' sciencecannot be so easily labeled, whatever the definition of "mechanical" one chooses to invoke. No matter which facet of the mechanical philosophyone appeals to, it will be argued that Cartesian science does not happilyfit that description, and may actually comprise an outright violation ofthe adopted mechanical tenets. In particular, it will be demonstrated that any purelymechanistic, local, or reductivist interpretation of Descartes' science fails to take full account of his intricate treatment of thephenomena of plenum motion. There remains a global, non−reductive, andsomewhat "holistic" conceptual element at the heart of Descartes'

physicaltheories—namely, the Cartesian conservation law for the quantity of motion (or sizetimes speed). Acknowledging the diverse and complex function of theCartesianconservation law will thus form the first part of our investigation, whileits importance for the mechanical philosophy debate will comprise thesecond half.

1. Quantity of Motion.

After a long period of development and maturation,Descartes' conservation law for the quantity of motion, or productof size and speed, finally receives its canonical presentation in the *Principles of Philosophy* (1644)[1]:

> [Motion] has a certain and determinate quantity, which we can understandeasily to be able to remain always the same in the whole universe, eventhough it may change in its individual parts. That is why we might thinkthat when one part of matter moves twice as fast as another which is twice as large, there is the same amount ofmotion in the smaller as in the larger. (Pr II 36)

This conservation principle serves as the basis ofDescartes' three laws of nature, which, in turn, describe the basic motions ofmaterial bodies in the Cartesian plenum. Quantity of motion figures mostprominently in the third natural law, as well as theaccompanying seven collision rules which comprise the specific instances ofthat law. In short, the third natural law dictates that colliding bodiesmust either retain all their motion or transfer as much motion as they lose (thus conserving quantity of motion; Pr II 40). God's "immutability"constitutes the foundation of the conservation principle, since Descartesreasons that "it seems obvious to me that it is none other than God himself, who createdin the beginning both motion and rest in the whole of matter, and now preserves through his normalconcourse alone the same a mount of motion and rest as he placed in it

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I will identify passages from theMiller and Miller (1983) *Principles* according to the following convention: Article 15, Part II, will belabeled "Pr II 15." Other translations are based on the Adam and Tanneryedition of the *Oeuvres de Descartes* (Paris: Vrin, 1976), with passages marked, "AT", followed by volume andpage number.

atthat time." (Pr II 36)

Nevertheless, it does not appear that any a priorijustification can be given, based on God's immutability, for privileging quantity of motion (size timesspeed) over the range of all possible quantitative relationships (e.g., Whynot "size + speed", or "size $\times$ speed^2"?) This is an especially troublesome dilemma for the Cartesians given thefoundational role of quantity of motion in Descartes' physics. Since this quantity, size times speed, appears in many otherseventeenth century scientific tracts, however (Gabbey 1973, 383), it isprobable that Descartes likewise assumed that it was the quantity conserved in the interactions of his plenum, ormatter−filled, world. For instance, Descartes must have been familiar withmany of the Scholastic "impetus" theories which oftenmeasured a body's force of motion by its speed or velocity and its quantity of matter.Whereas the impetus theories chiefly involved "unconstrained" bodily motions and interactions, such as the "violent" motion of anaturally resting terrestrial body when thrown into the air, anotherpotential source of Descartes' quantity of motion was probably derived from his familiarity with variousstatics principles, especially the various dynamical renditions of the "lawof the lever". The similarity of quantity of motion to the quantitiesemployed in his work on statics is quiteevident in many letters on analysis of suspended weights (and other simplemachines) from the late 1630s: for example, "to raise a 100−pound weight to a height of one foot twice is the same asraising a 200−pound weight to a height of one foot. . . . (AT II229)"

Descartes' "statics principle", as we may dub it, differs from quantity of motion in that it comprisesthe product of weight and an infinitesimally small displacement, as he isat pains to point out: e.g., "note that I say 'begin to fall', and notsimply 'fall', since it is only the beginning of the fall [of the weights] that weneed to consider (AT II 233)". Nevertheless, the similarities betweenquantity of motion and his statics principle are quite strong. In onesense, of course, quantity of motion is non−instantaneous; i.e., it

includes the Cartesian concept ofspeed, which can only take place over a non−instantaneous temporal period(as best exhibited in the collision rules, Pr II 46−52). Yet, quantity ofmotion is also inseparably linked with the instantaneous property[2] which he sometimes labels, "tendency" (*tendere,* Pr II 39), althoughthe *Principles* employs several designations interchangeably indepicting this notion (e.g., "striving", *conatus,* Pr III 56; "firstpreparation for motion", *prima praeparatio ad motum,* Pr III 63). Tendencies, since they are involved in the (non−instantaneous)motions of bodies, are thereby coupled to the states of affairs presidingat a single instant. He states: "Of course, no motion is accomplished in aninstant; but it is obvious that every moving body, at any moment in the course of its motion, isdetermined (*determinatum*) to persevere in its motion in some directionalong a straight line, ..." (Pr II 39) The explanation would seem toimply that a tendency has a determination (which roughly corresponds to the direction ofmotion), for he also states in Article 39 that "each part of matter, . . .tends to persevere in its motion along only straight lines. . .."[3] Another term apparently used to signify quantity of motion is “agitation” (*agitation*), a concept which figures prominentlyin those sections of the *Principles* devoted to celestial phenomena: "Once moved, gold, lead, or other metalsretain more agitation, or force (*vis*) to persevere in their motion, than pieces of

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The inconclusive debate on Descartes’understanding of instants, i.e., whether instants are durationless orcomprise some length, will not be discussed (since it is a separateproblem). See, Garber 1992, 268−270.

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Consequently, determination applies toboth instantaneous tendencies and non−instantaneous motions, as Garberlikewise concludes (1992 219−220). On Descartes’ statics and dynamics, see Westfall 1971, chap. 2: Westfall’streatment of the development of Descartes conservation principle generallyagrees with the analysis above. For more on the pre−history ofDescartes’ natural philosophy, see Des Chene 1996; and for the mechanical philosophy,Gabbey 1985. The details of section 1 are treated at greater length inSlowik 1999, and owe a great deal to Gabbey 1993.

wood or rocks do of the same size and shape." (Pr III 122).The analysis of the agitation force, in Part III of the *Principles,* isequivalent to the definition of a moving body's QM in Part II, since theyboth measure a body's "force to persevere (*perseverare*) in its motion, i.e., in motion at the same speed in the same direction"(Pr II 43). Therefore, quantity of motion is also a measure of agitationforce, while the agitation force, in turn, is a measurement of theinstantaneous tendenciestowards motion exhibited by Cartesian bodies (as Garber 1992, 208, andPrendergast 1975, 460, both agree).

In fact, since Cartesian motion requires duration (i.e., it does not takeplace at the level of instants), the distinction between instantaneoustendencies towards motion, as measured by quantity of motion, andinfinitesimal displacements, as incorporatedin the Descartes' statics principle, becomes difficult to maintain.Bearing in mind that instantaneous tendencies towards motion are not "real"motions, in Descartes' sense, it might be more accurate to regard them as moreakin to an infinitesimal displacement (change of place). In addition, sinceCartesian matter is ultimately pure extension, a body's shape, volume, surface area, etc., are the sole factors which (along withspeed) determine its force of bodily motion. Consequently, "weight" is merely the by−product of the tendencies of plenumobjects "to persevere in" straight line uniform motion (which is measured byquantity of motion). Tendencies towards uniform motion are thus the cause of the descent of terrestrialbodies, as well as the increasing velocity, or acceleration, of theirfree−fall over time (due to the incremental build−up of each separate"push"). In short, weight is as closely linked to size and speed, asinstantaneous tendencies and quantity of motion are related toinfinitesimal displacements and the statics principle.

To summarize our discussion thus far, quantity of motionwould appear to serve two primary functions: (a) it is a measure of abody's non−instantaneous size × speed, as in thefamous collision rules; and (b) it is a measure of a body's instantaneous tendency towards motion. Coming to grips with thisduality—a duality which lies at the heart of

Descartes’conservation principle−−will be of great importance for our investigation below, for the attempts to classify the general nature ofhis natural philosophy directly depend upon this seldom recognizedfeature.

2. Identifying the Mechanism inDescartes’ Natural Philosophy

As one would expect given its loosely definedparameters and potential breadth of scope, the concept of a “mechanistic” or “mechanical” science derives from a host of competing, and often contradictory,philosophical intuitions. The implicit vagueness of the definitions thatdraw upon these intuitions not only threatens to undermine the veryplausibility and applicability of the“mechanical” concept, but would likewise seem toundercut any interpretation of its alleged socialand natural ramifications. In what follows, a few of the major trendswithin the plethora of proposed delineations of the mechanical philosophywill be examined, and compared with our understanding of Descartes’ natural philosophy in light of section 1.

Holism. The confusion surrounding Descartes’ alleged mechanistic legacy is nicely exhibited in a recent survey, by V.Dusek, regarding the holistic influences on the development of modernphysics. In places, Dusek seems to suggest (quite correctly, in my opinion)that Descartes’ physics is closer in spirit to later−day continuum mechanics, which issupposedly holistic, than to the sort of atomistic, reductionist physics ofthe Newtonians (Dusek 1999, 23, 204). Yet, in other passages, Dusekapparently reverses this judgment, now categorizing Descartes’ physics as atomistic andreductionist (12, 247). One might reasonably wonder, at this point, ifthere exists any consensus on the nature of Descartes’ naturalphilosophy, at all.

Dusek’s uncertainty most likely stems from afailure to acknowledge the dichotomous role of quantity of motion inDescartes’ physics, as outlined above. If one confines their interpretation of theconservation principle to the context of its first

presentation—thatis, Part II of the *Principles*, which also presents the laws of motionand collision rules—then one will probably view quantity of motion as a sort of kinematicproperty reducible to the individual, durational motions of bodies beforeand after impact.[4] The universal value of quantity of motion, consequently, will be judged to be the mere sum of eachindividual body's size × speed. Yet, thistype of reasoning fails to take account of quantity of motion's role as the measure of a body's instantaneous perseverance in straightline uniform motion, a concept that bears close ties with his statics. Whenthe force of a body to descend is balanced against that of another, as in simple machines,infinitesimal or instantaneous quantities are invoked in the mathematicalanalysis. Furthermore, these quantities require a system of bodies whose interactions areinterconnected or harmonized in a kind of "holistic" fashion; which is nota model readily derived from our experience of the kinematical impact ofindividual moving bodies, as employed by Newton's, or even Descartes', collision rules. Rather, the arrangement ofbodies in a balance will only allow constrained, synchronous motions of theentire assemblage: i.e., to analyze the motion of one body, you have toindirectly take into account the movements of all bodies−−such that, if one descends, the other rises (atleast hypothetically via the law of the lever, and for minute distances orspeeds). Consequently, Descartes' instantaneous version of quantity ofmotion, labeled (b) above, would seem to necessitate a system whose overall conserved force cannot be simplyreduced to the isolated, individual motions of bodies.

Since the analysis of motion in the *Principles* often exhibits thisstatics−based approach, it would seem that Descartes proceeded toincorporate, or conflate, this holistic interpretation of instantaneoustendencies with his durational, size × speed, analysis of

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4 "Kinematic" refers to the study ofmotion per se, unlike "dynamics" which studies motion under the action offorces.

bodily motion. For instance, at the end of Part III heclaims that "for as all bodies in the universe are contiguous and act uponone another, the motion of one body is dependent on the motion of all theothers, and therefore varies innumerous ways." (Pr III 157).[5] This holistic emphasis is presented in a slightly more detailed manner inan analogy involving a circle of air particles, with positions labeled EFGHI spaced along its circumference: hestates, "if the air at E is pushed towards F, the air at F will circulatein the direction of GHI and return to E, such that one cannot feel itsweight, in the same way that one cannot feel the weight of a rotating wheel if it is balanced perfectly on itsaxle." (2 June 1631, AT X 205) Needless to say, to envision the motion of aseries of plenum particles as involving so little effort, i.e., as if theyhad no weight, strongly attests to the non−local synchronization or harmony of Cartesian motion (as wellas to the continuing influence of simple machines on Descartes'thinking).

The global or "holistic", as opposed to local, featureof Cartesian natural philosophy is seldom discussed in theliterature.[6] Most commentators appear to favor a reductionist reading of Cartesianmatter and motion, as does E. Grosholz, in her claim that "the whole is notgreater than the sum of its parts, and there is no systematicinterdependency among theparts, or among the parts and the whole." (1991, 76) C. Merchant reachessimilar conclusions, contrasting the reductionist particle−based approachof the mechanical school with what she takes to be the "holistic" outlookof modern ecology. As for the latter, "no element of an interlocking cycle can be removed without the collapseof the cycle. . . . Each particular part is defined by and dependent on thetotal context. The cycle itself is a dynamic interactive relationship ofall its parts, ..."

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Descartes' hypothesis of instantaneouscircular motions of plenum bodies (Pr II 33) is also relevant to thisdiscussion, needless to say.

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For some studies of teleology inCartesian physics, see; Collins 1971, Part 1; and, Machamer 1976.

(1980,293) In an ironic twist, Merchant's definition of a holistic system would seem to be a more accuratedescription of Descartes' cosmos than of any ecological system: that is,the removal of a part of the Cartesian plenum would violate theconservation principle, and possibly derail the large scale circular motion of bodies (Pr II33), lock−up the harmoniously arranged vortex rotations (Pr III 65−66), or,at the least, force an instantaneous increase in the motion of otherparticles located somewhere in plenum. On the other hand, we have ample knowledge of many plant and animalspecies whose removal from, or extinction within, a given ecological systemdid not bring about an equally large scale change, and possibly did notadversely affect the ecosystem, at all.

In all fairness, both Grosholz and Merchant do raiselegitimate concerns, especially regarding the naive mechanism of some ofDescartes' specific biological and physical models (such as the human body). But,Grosholz and Merchant extend the charge of crass reductionism to the entire Cartesian scheme of natural philosophy, andthus overlook the very tangible "systematic interdependency among theparts", to use Grosholz own phrase, revealed in the workings of quantity ofmotion In the case of Merchant, furthermore, some of the difficulties may be traced to her characterizationof the general features of Early Modern mechanistic theories, where it isalleged that "nature is made up of modular components or discrete partsconnected in a causal nexus that transmitted motion in a temporal sequence from part to part." (228) This isnot an accurate description of Descartes' *overall* theory, as was explained in section 1, for Cartesian bodies interactsimultaneously or synchronously as a connected whole, and not "in atemporal sequence from part to part". In fact, the somewhat bizarre,holistic consequences of Cartesian physics are nicely captured in J. Henry's succinct summary that "when [Cartesian] motionstarted somewhere in the world, somewhere else in the world thecorresponding amount of motion had to be absorbed." (Henry 1997, 60)

Atomism. If atomism is a central component of anymechanical natural philosophy, then Descartes is not a mechanist. In the*Principles*, he offers the (Scholastic−based) argument that since any part of matter,or extension, is potentially divisible either in thought or by God, atomismis impossible (Pr II 20). Rather, Descartes' preferred units of matter are his three basic elements, which are mutuallyconvertible given the intrinsiccontinuity of the Cartesian extended substance. This corpuscularian theory,as it is often called, does not necessarily constitute a hybrid type ofatomism. Indeed, Dusek (24) would apparently classify it as a "monism", which he regards as an extreme form of holism, and the polar opposite ofatomism. (Descartes' dualism of matter and mind complicates thisissue, however, and would appear to disqualify his theory from a pure"substantival monism", rendering it a mere "material monism",instead.)

The continuity of the Cartesian plenum,moreover, leads us back to the holistic emphasis in Descartes' thinking, as opposed to the atomist and local. As mentioned above, Dusekregards the mechanics of continuously extended materials, i.e., continuummechanics, as a holistic theory (1999, 230). Nevertheless, drawing such an analogy betweenDescartes' plenum physics and continuum mechanics should not be taken toextremes, since they differ on matters of more than just historical origin.Yet, many of the concepts of continuum mechanics bare an interesting resemblance to various Cartesianhypotheses: for example, an elementary textbook notes that "observedmacroscopic behavior [of bodies] is usually explained by disregardingmolecular [or particle] considerations and, instead, by assuming the material to be continuously distributed throughout itsvolume and to completely fill the space it occupies." (Mase 1970, 44)Correlating spatial volume with indefinitely−divisible matter is admittedlyquite Cartesian, although one has to stretch the interpretation of this passage a bit to encompass Descartesdecidedly corpuscularian thesis of the three material elements. Evenconceding this last point, there is a sense in which Descartes

doesdisregard the individual, local behavior of bodies (and elements) in favor of a "holistic" treatment of plenumphenomena, much like the continuum theorist’s continuously distributedmatter. A notable instance of this type of thesis is the function ofDescartes’ first elements of matter: i.e., as the most minute material particles,these elements must, in a quasi−miraculous manner, fill in the gaps left inthe wake of the larger second and third elements’ motion through the plenum (Pr III 52). It is hard to see how this holisticfeature of plenum activity could be derived exclusively from the local behavior of individualfirst element matter, especially if one insists that their behavior issolely governed by the durational “size times speed” version of quantity of motion, which only takes account of the size andspeed of the locally interacting bodies.

Hylomorphism. If there is any category on whichDescartes’ acclaim as a arch−mechanist can be truly lain, it most likely centers uponhis repudiation of the doctrine of Scholastic forms. Rejecting the viewthat material objects are comprised of an inert property−less substratum (primary matter) and a determinate quality−bearingessence (substantial form), Descartes confidently asserted that “all of the forms [i.e., properties] of inanimate bodies can beexplained without having to assume anything else for this in their matterbut motion, size, shape, and the arrangement of their parts.” (ATXI 25−26).

Overall, Descartes’ plan is quite simple: reduce the discussion of theclass of non−observable metaphysically suspect properties, such as color,weight, taste, etc., to a discussion of the empirically sound observableproperties of size, shape, and motion. The direct impact of inert, qualitatively indistinct chunks of matter thusserves as the foundation of his physics−−and it is this exclusive emphasison body−to−body contact which is highly characteristic of the mechanicalphilosophy.

Nevertheless, the denial of “qualitative” bodily properties (other than extension) and the endorsement ofbody−to−body contact are not straightforwardly related or

defined; and arenot sufficient in themselves to either qualify or disqualify one as a mechanist. One can embrace Scholastic−like bodily qualities and yet still adhereto a contact−mechanical thesis, as the case of Leibniz clearlydemonstrates. In fact, many of Descartes’ contemporary critics, who we also regard as mechanical philosophers, werequite content to accept the notion that physics deals with the localmotions of bodies, but that mere extension and speed were not enough to capture the full variety of physical phenomena: e.g.,Gassendi, Newton, etc. (Copenhaver 1998). As for Descartes, it would appearthat this his contact−mechanical physical theory likewise did not deter himfrom postulating a rather“substantial form”−like concept; namely, the humansoul, which is diffused throughout a body but, like Scholastic “heaviness”, can still a act at point (i.e., the pineal gland and thecenter−of−gravity, respectively; Garber 1992, 98).

If we return the conservation principle, furthermore, which has been ourmain subject of investigation, there is a strange sense in which Descartes’conception and application of quantity of motion similarly posits a sort ofsubstantial from, although it is global version diffused throughout extension and able to act at manypoints simultaneously. Despite his rejection of "mentalistic" substantialforms within *individual* bodies, such as weight (e.g., *SixthReplies*, AT VII 441−442), Descartes nevertheless invokes a force in the *wholeof matter* that acts in much the same way: first, it is a quasi−"property" coupled(by God) to a pre−existing material substratum (in this case, the materialworld); second, its teleological−like conservation of quantity of motioncannot be reduced to matterand motion alone (since God’s sustaining act is required). The resemblanceto substantial forms, although largely coincidental, did cause Descartessome concern: in a letter to More, he admits that he had been previouslydisinclined to discuss his views on force out of a "fear of appearing disposed to favor the beliefs of thosewho regard God as a world−soul conjoined to matter." (July 1649, AT V 404)Quantity of motion may not be God’s soul united with the material world,yet many of its holistic,

irreducible, and "mysterious" features nevertheless betray a strong teleologicalbias—a bias that runs counter to our preconceived notions of the“mechanical” philosophy.

3. Conclusion

The subject of this essay, it should be recalled,has not been to exhaustively compare all the properties of Descartes’ physics with the tenets of the mechanical philosophy. Even if this projectcould be carried out, which is doubtful given the vagueness of themechanical “paradigm”, it would still not undermine hefact thatnumerous aspects of Descartes’ theory differ quite radically fromour modern interpretation of the mechanical school (and Descartes’ science, for that matter). Rather, our more limited goal has been toreveal the two distinct, if closely linked, aspects of Descartes’conservation principle−−i.e., the measure of a body’s non−instantaneous,durational, size × speed, and themeasure of a body’s instantaneous, non−durational, tendency towardsstraight−line uniform motion—and to show how these two versions of quantity of motion relate to the mechanical and non−mechanical features ofthe Cartesian physical system. The instantaneous interconnected−ness of theCartesian plenum, which bares many of the hallmarks of a holistic outlook,defies a classification purely along the lines of "size × speed"; and likewise defies attempts to exclusively saddle Cartesianscience with a host of modern social/environmental ills.[7]

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