The Fluid Plenum: Leibniz on Surfaces and the Individuation of Body

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THE FLUID PLENUM: LEIBNIZ ON SURFACES AND THE INDIVIDUATION OF BODY[1]

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In several of his writings from the 1680s, Leibniz presents an argument for the claim that there are no determinate or precise shapes in things, and states that shape contains something imaginary and relative to our perception in much the same way that qualities such as heat and colour do.[2] Most of the commentators who have studied the relevant texts have interpreted them in such a way that they support, or are at least consistent with, an idealist analysis of body. These scholars see Leibniz as arguing that since an actual shape would have to be infinitely complex and since there could be no infinitely complex shapes, there are literally no shapes or surfaces in the world.[3] According to a more recent interpretation, however, Leibniz's remarks about shape do not support an idealist analysis of body. On this interpretation, Leibniz only intends to argue against the existence of finitely

describable shapes. Bodies do have real surfaces, but these surfaces are infinitely complex.[4]

In this paper, I argue for two claims about Leibniz's critique of the mode of shape. The first is that there are significant challenges for any interpretation that sees Leibniz's views on shape as consistent with realism about surfaces. The second claim is that in focusing on whether or not a shape or surface is or could be infinitely complex, previous commentators have missed the real point Leibniz is trying to make about the possibility of shape in an infinitely divided plenum.[5] In my view, Leibniz wants to show that infinite division raises serious problems for the existence of metaphysically determinate boundaries among bodies, thereby making it difficult to account for the individuation of bodies – however body is construed. The shape argument thus poses a difficulty for any interpretation of Leibniz's metaphysics according to which the world is constituted (at some level of analysis) of bodies that are metaphysically individuated from one another. This by no means settles the issue of whether Leibniz envisioned an idealist reduction of the world of extended things in the 1680s. However, taken in conjunction with his repeated claims that the other modes of extension are imaginary and his view that these modes are dependent upon one another, his claim that shape is literally imaginary constitutes strong evidence that in this period he believed that the world, as it is in itself, does not contain genuinely extended things.[6]

I. THE RELEVANT TEXTS

Leibniz's suggestion that there is something imaginary about the Cartesian modes of extension can be traced back to some late 1670s writings concerning motion.[7] He does not discuss the reality of shape, however, until the early 1680s. One of his earliest comments about shape is found in a 1683

[4]Samuel Levey, 'Leibniz on Precise Shapes and the Corporeal World,' in, *Leibniz: Nature and Freedom*, edited by Jan Cover and Donald Rutherford, 69–94.

[5]I assume in this discussion that Leibniz takes the shape of a body to be its surface. There are at least two pieces of evidence for this. First, in one of his arguments concerning shape, he seems to treat shape and surface as synonymous (G, II 119 [M 152]). Second, in a 1669 letter to Thomasius, he says explicitly that 'shape is the boundary of a body' (A, VI, ii, N54 [RA 337]). An anonymous referee has pointed out, however, that there may be room for disagreement with this assumption. In a (1679–89?) text titled 'On Euclid's *Elements*', Leibniz offers an extremely complex critique of the notion of surface as traditionally defined. This text is discussed in detail in Samuel Levey, 'The Interval of Motion in Leibniz's *Pacidius Philalethi*', *Nous*, 371–416. See also, Laurence Bouquiaux, *L'harmonie et le chaos: le rationalisme leibnizien et la 'nouvelle science*, fn. 241–2.

[6]All that is meant by '*x* is genuinely extended' is that *x* has parts, however individuated, that bear spatial relations to one another. Nothing is implied about the nature of that which is extended.

[7]See, for example, A, VI, iv, 277 [RA 257]; A, VI, iv, 360 [RA 229].

essay entitled 'Wonders Concerning the Nature of Corporeal Substance'. In this piece, Leibniz states that extension and motion cannot be distinctly understood, although they are less confused than other qualities, since

> on the one hand we are always embroiled in the difficulties concerning the composition of the continuum and the infinite, and on the other, because there are in fact no precise [*certae*] shapes in the nature of things, and consequently, no precise motions.
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> (A, VI, iv, 279 [RA 263])

Unfortunately, Leibniz does not offer any justification for thinking there are no precise shapes; nor does he even make clear what he means by the term 'precise' in this context. Nevertheless, there are two things that this text does make clear. First, Leibniz has a critique of motion that is grounded in something distinct from relativity considerations.[8] In fact, it appears from this text that even if the relativity concerns could be overcome, there would still be a problem for our distinctly understanding motion, or at least 'precise motions'. Second, although he is discussing the possibility of our having a distinct understanding of extension and motion, Leibniz believes that the problem with shape has to do with the nature of things, and not merely with our ability distinctly to understand them. Later in the same text, in fact, he makes the stronger claim that all of the modes of extension are phenomena 'just as color and sound are phenomena, rather than attributes of things containing a certain absolute nature without relation to us' (A, VI, iv, 279 [RA 263]). This is not simply a claim about our ability to distinctly understand the modes of extension; it is an explicit statement that the modes of extension are dependent on the mind in much the same way that the secondary qualities are.

Leibniz does not provide any arguments in support of theses claims about shape until the mid-1680s. As some commentators have noted, Leibniz seems to present two distinct lines of reasoning, both of which depend on the premise that in a plenum, matter is actually infinitely divided as a result of infinite variety in the motion of its parts.[9,10] The first, which is presented in

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[8]In his earliest discussions of the modes of extension, Leibniz argues that there is something imaginary or ideal about motion because it is relative to a particular frame of reference. This, he claims, is related to the mistake of taking one frame of reference to be the correct one (A, VI, iv, 360 [RA 229]). For discussion of this argument, see Daniel Garber, 'Leibniz: Physics and Philosophy', in *The Cambridge Companion to Leibniz,* edited by Nicholas Jolley, 305–9; Levey, 'Leibniz on Precise Shapes . . .', op. cit., 70–3; Paul Lodge, 'Leibniz on the Relativity of and the Motion of Bodies', *Philosophical Topics*, 277–308.

[9]Adams, op. cit., 229–32; Levey, op. cit., 74; Sleigh, op. cit., 211.

[10]The world is a plenum, according to Leibniz, because in creating this world God acted so as to maximize 'quantity of essence', and the possible world that contains the most essence is completely full (G, VII 303). A plenum must be actually infinitely divided because in a plenum all motion involves circuits and in order for any parcel of matter to move through the irregular

only one text, is an argument that a body's shape could exist neither for some period of time nor for an instant:

> It is true that it will always be possible to draw an imaginary line at each instant; but that line will endure in the same parts only for that instant, because each part has a motion different from every other, since it expresses the whole universe differently. Thus there is no body that has any shape for a definite time, however short it might be. Now I believe that what exists only at a moment has no existence, since it starts and finishes at the same time.
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> (A, VI, iv, 310 [RA 297])

According to this argument, a supposed shape cannot exist for any period of time (however short) because every part of that shape, no matter how small, has a motion that is different from its neighbouring parts. It cannot exist for a moment because nothing can exist for only a moment; thus, there are no shapes. On the assumption that all things are in a continuous state of change, the first part of this argument is sound. In fact, Descartes would agree that every part of a plenum must be in a continual state of modal alteration.[11] The synchronic aspect of the argument, however, is not so obviously sound, since it seems Leibniz's justification for the claim that nothing has a momentary existence is in need of further development. I believe that Leibniz has the resources to defend this assumption, however, and that furthermore, there is no reason to think he ever had doubts about its soundness.[12] Nevertheless, the fact that he mentions this argument only once and appeals to another argument in several texts from this period suggests that this alternative line of reasoning is the one he deems most forceful.[13]

Leibniz offers a clear statement of this second line of reasoning in a 1687 letter to Antoine Arnauld:

> shape itself, which is of the essence of finite extended mass, is never exact and specific in nature, because of the actual division *ad infinitum* of the parts of matter. There is never a shape without inequalities, nor a straight line without curves intermingled, nor a curve of a certain finite nature unmixed with some other, and in small parts as well as large, with the result that shape, far from

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circuits that exist in the plenum, that parcel of matter must be infinitely divided into smaller parcels of matter (G, IV 370).

[11]Descartes, *Principle of Philosophy, The Philosophical Writings of Descartes*, edited and translated by J. Cottingham, R. Stoothoff and D. Murdock, 239–41.

[12]I argue for this in 'Leibniz on Shape and the Cartesian Conception of Body', in *A Companion to Rationalism*, 262–81. Samuel Levey offers a detailed discussion of this argument in his '*Dans les corps il n'y a point de figure parfaite*: Leibniz on Time, Change and Corporeal Substance', forthcoming in *Studia Leibnitiana*.

[13]It is worth pointing out that the conclusion of the diachronic argument could not be that the surface of a body is too complex to be characterized in terms of seventeenth-century, finite geometry. It is clearly an argument against the reality of any surface – infinitely complex or otherwise.

being constitutive of bodies, is not even a wholly real and specific quality outside of thought, and one will never be able to fix upon a certain precise surface in a body as one might be able to do if there were atoms.

(G, II 119 [M 152])

Leibniz repeats the main argument of this passage at several places in his correspondences with Arnauld: the parts of body are actually divided to infinity; therefore there is no fixed and precise shape (or surface) in body.[14] Although it is possible that Leibniz is making the point that shapes are imaginary because they are always changing, this does not seem to be the most natural way to read these texts. Rather, it seems that the point is that there is no surface that is complex enough to reflect the infinite complexity of the plenum, even at an instant. Leibniz offers a slightly different formulation of the argument in 'Primary Truths'. In this text, he argues that there are no determinate shapes in actual things on the grounds that

none can be appropriate for an infinite number of impressions. And so neither a circle, nor an ellipse, nor any other line we can define exists except in the intellect, nor do lines exist before they are drawn, nor parts before they are separated. Extension, motion, and bodies themselves ... are not substances, but true phenomena like rainbows and parhelia. For there are no shapes in things.

(C 522 [AG 34])

Here again, Leibniz makes no mention of diachronic considerations. The idea seems to be that any actual surface, considered over time or at an instant, would have to be infinitely complex and thus is impossible. This text is unique in that Leibniz appeals to the premise that no shape can be appropriate for infinite impressions, rather than the premise that the plenum is infinitely divided. Nevertheless, they are closely related in that the reason any supposed shape would need to be infinitely complex is that the plenum is infinitely divided and thus the purported surface of any body would need to reflect the influence of infinitely many surrounding bodies. Unfortunately, Leibniz does not offer an explicit justification for the main premise, and as we shall see, an understanding of his reasoning in support of this claim is crucial for determining whether Leibniz is a surface realist in this period.

A general form of argumentation emerges from these texts, one to which I will refer in what follows. On the assumption that a genuinely extended plenum of matter or body, however construed, exists,

(1) Matter is actually infinitely divided (but not into points, infinitesimally small particles, or any other minima).[15]

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[14]See fn. 1 for the relevant texts.
[15]According to Leibniz, points, as well as lines, surfaces and instants are not parts of things, but are rather *extrema*, *termini* or limits of things (A, VI, iii, 78: 566 [RA 209–11]; RB II, xiv, 152).

(2) So, there are no determinate shapes in things.[16]

(3) So, shape contains something imaginary; it is not a wholly real and specific quality outside of thought.

This formulation (hereafter, the 'Shape Argument') makes it clear that an account of the reasoning behind the move from (1) to (2) is crucial to our understanding of the argument. Also important is what Leibniz means by the claim (2) that there are no determinate shapes in things. Unfortunately, Leibniz is not very forthcoming about these issues; but we have slightly more to go on than the premises stated above. Specifically, we also have the premise Leibniz uses in the 'Primary Truths' version of the argument, namely, that no shape is appropriate for infinite impressions. It seems likely that Leibniz sees this premise as explaining why infinite division is inconsistent with determinate shape. Of course, this raises a further interpretative question: what is meant by the claim that no shape is appropriate for an infinite number of impressions? The differences between the surface realist and the surface anti-realist will turn out to depend on how this question is answered.

There is a further consequence of this argument that Leibniz draws in a few of the texts we have cited:

(4) So, if there existed nothing but matter and its modifications (extended mass), bodies would be purely imaginary or apparent.[17]

Leibniz's criticisms of the reality of the modes of extension are intended to show, at least, that Descartes's conception of corporeal substance is too austere to account for the reality of matter. Without entelechies, he claims, extended mass is only a pure phenomenon; it cannot be something real, nor can it even be a representation of something real. The fact that (4) is the conclusion he draws is significant because he does not draw the conclusion we would expect him to draw if he envisioned an idealist analysis of body; namely, that body however construed is a phenomenon. However, we cannot infer from the conditional form of this conclusion that Leibniz is a realist about body or matter. Nothing about the type of analysis Leibniz has of body follows from the truth of (4).[18]

As modes of (spatially or temporally) extended things, their existence is entirely dependent upon the extended things they bound. So, considered apart from that which they bound, they have no existence – they are mere abstractions.

[16]Leibniz expresses this claim in a variety of ways. In addition to saying there are no 'determinate' shapes (G, II, 119; A, VI, iv, 312), he says there are no 'precise' shapes (G, II 77, 119), 'exact' shapes (A, VI, iv, 279; G, II 98), and 'fixed' shapes (G, II 77, 98). Sometimes, however, he simply says that there are no shapes in things (e.g. C 522).

[17]G, II 98 and 119 [M 122–3, and 152–3].

[18]This conclusion is consistent with an analysis of matter according to which it is an appearance that is grounded in a non-spatially extended world of immaterial substances. On such an

II. SURFACE REALISM AND THE SHAPE ARGUMENT

The argument as formulated in the previous section is neutral with respect to how strongly we should interpret the central conclusions (i.e. (2) and (3)), and it offers no account of the line of reasoning that licenses the move from (1) to (2); that is, it tells us nothing about why infinite division undermines the possibility of determinate shapes. Of the few commentators who have written on the relevant texts, most have interpreted the conclusions quite strongly: there are quite literally no surfaces or shapes; and shapes are imaginary or mind-dependent in much the same way that secondary qualities are.[19] These interpreters take the shape argument to be pointing out that there is something absurd or incoherent about the idea of an infinitely complex shape, and they see the argument as supporting an idealist analysis of body. However, idealist interpretations of Leibniz's views in the 1680s have come under attack in recent years by scholars who find evidence of realism about extended, corporeal substance in Leibniz's writings from this period. According to these scholars, the ultimate constituents of the world in Leibniz's 1680s metaphysics are not simple, immaterial beings, but are rather, spatially extended entities with properties normally associated with body, including shape and motion.[20] Advocates of a realist interpretation of Leibniz's metaphysics of body must therefore interpret the argument such that the central conclusions are consistent with the existence of metaphysically determinate surfaces, since a body is just a particular delimited parcel of matter.[21] Specifically, the realist interpreter must offer an account of the claims that (2) there are no determinate,

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analysis, bodies would not be merely apparent, as are dreams, but would actually represent an extra-mental reality of substances.

[19]See Adams, op. cit.; Sleigh, op. cit. According to these commentators, the ontology to which Leibniz is committed in this period is one according to which the world as it is in itself does not contain extended things. Bodies are appearances of groups of immaterial substances; or alternatively, bodies are collections of immaterial substances that are perceived as spatially extended. Thus when Leibniz says that there are no determinate shapes, these commentators take him to be committed quite literally to the claim that there are no shapes; and when he says that shapes are imaginary or phenomenal, they take this to mean that the extension we attribute to bodies is contributed by the mind; outside of the mind, there are only immaterial substances that do not bear any spatial relations to one another.

[20]Realist interpretations come in a variety of forms. The most prominent advocate is Daniel Garber, in 'Leibniz and the Foundations of Physics: The Middle Years', 27–130 in *The Natural Philosophy of Leibniz*, edited by Kathleen Okruhik and J. R. Brown. See also, for example, Glenn Hartz, 'Why Corporeal Substances Keep Popping Up in Leibniz's Later Philosophy', *British Journal of the History of Philosophy*, 193–207; Levey, 'Leibniz on Precise Shapes . . .,' op. cit.; and Peter Loptson and R. T. W. Arthur, 'Leibniz's Body Realism: Two Interpretations', *The Leibniz Review*, 1–42.

[21]This is not to say that Leibniz would need to be committed to real surfaces at every level of analysis. It could be that most bodies have imprecise boundaries. However, if the world is genuinely spatially extended, its reality must be grounded in extended substances, which must be perfectly determinate, individuated and unified.

precise, fixed, etc. shapes, and (3) shape is an imaginary property or a true phenomenon. In addition, realists, unlike idealists, must offer an account of the metaphysics of determinate surfaces; that is, they must offer an account of what it is in virtue of which bodies are metaphysically delimited from one another.

There is clearly significant tension between Leibniz' remarks about shape and his metaphysical views as understood by realist interpreters. The only way to resolve this tension, it would seem, is to attribute to Leibniz some type of distinction between the real, metaphysically determinate surfaces that are characteristic of actual bodies and the specific or precise surfaces that he insists do not exist. This is the strategy adopted in a recent paper by Samuel Levey.[22] On Levey's view, the claim that shape is imaginary does not commit Leibniz to anything more than the view that any shape we perceive or conceive is a representation that is partially constituted by the imagination. It does not, therefore, commit Leibniz to the view that there are no metaphysically determinate surfaces of bodies. This is an important aspect of his interpretation, since Levey thinks that Leibniz is a realist about surfaces. However, if Leibniz is committed to surface realism, then he must mean something quite specific when he says that there are no determinate shapes in things. According to Levey, Leibniz only means to deny the existence of shapes or surfaces that could be described employing the mathematical resources available to seventeenth-century philosophers. There are surfaces; but these surfaces have an infinitely complex or 'fractal' structure and are thus too complex to be characterized in terms of any combination of finite shapes.

To defend this interpretation, Levey offers an explanation of Leibniz's argument for the claim that there are no shapes. His interpretation of the argument tracks very closely the argument formulated in Section I, although of course there will be differences between the way he and an anti-realist about surfaces interpret the premises. The argument begins with the assumption that the material world is a plenum and that motion in a plenum requires actual infinite division. This account of the material world raises two critical issues. The first is the question of the composition of the continuum: what are the ultimate, fundamental constituents of the material world? Leibniz argues that neither points, nor infinitesimally small parcels of matter, nor any other minima could constitute the ultimate constituents of the material plenum, and so some other account of composition is needed. The second issue is the question of how we are supposed to understand the structure of the infinitely divided plenum. Levey sees Leibniz's views about shape as primarily motivated by concerns about the structure of the continuum. He focuses on two early (1676) texts, one which compares the structure of the continuum with a folded tunic and the other which makes a similar point about the infinitely complex nature of motion.

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[22]Levey, 'Leibniz on Precise Shapes . . .', op. cit.

Accordingly the division of the continuum must not be considered to be like the division of sand into grains, but like that of a sheet of paper or tunic into folds. And so although there occur some folds smaller than others infinite in number, a body is never thereby dissolved into points or minima ... It is just as if we suppose a tunic to be scored with folds multiplied to infinity in such a way that there is no fold so small that is not subdivided by a new fold ... And the tunic cannot be said to be resolved all the way down into points; instead, although some folds are smaller than others to infinity, bodies are always extended and points never become parts, but always remain mere extrema.

(A, VI, iii, 555 [RA 185–7])

The motion of a moving thing is actually divided into an infinity of other motions, each different from the other, and ... it does not persist the same and uniform through any stretch.

(A, VI, iii, 565 [RA 207])

Levey's view is that the fact that matter and motion are everywhere variegated has immediate implications for shape:

In nature there will be no part of body whose shape can be perfectly described by straight lines or even by 'smooth' curves. Since every part of matter is in fact infinitely broken up into separate parts, each of which is moving with its own individual motion, to describe a given part of matter as having a shape constructible from straight lines or smooth curves is necessarily to neglect the variegation of the finer parts, and thus to neglect infinitely many details of its actual structure ... Yet now it appears that no shape could describe the structure ... since by the lights of traditional geometry, all the shapes there are are definable only by reference to straight lines or smooth curves.[23]

Therefore, the way Levey understands the argument through sub-conclusion (2) is as follows. Infinite division results in the actual surface of a body being a composite of the surfaces of an infinitude of bodies, each of which has a slightly different direction of motion. Even if we focus on one part of the surface of a body, that too will be a composite of the surfaces of an infinitude of bodies. Thus, no matter how far 'down' we go in our analysis, there will be no part of the surface that can be described as a shape, given the traditional understanding of shape as something definable by straight lines or smooth curves. When Leibniz denies that there are any 'precise' or 'determinate' shapes, he is claiming that the actual (metaphysically determinate) surface of a body defies precise mathematical description.[24]

This gives us a bit more insight into Levey's interpretation of the claim that shape involves something imaginary. He thinks that what Leibniz means by this is that sense-perceived shape is an appearance that is

[23]Ibid., 76.
[24]Levey discusses the fractal nature of a Leibnizian continuum in further detail in his 'The Interval of Motion ...', op. cit.

constructed in part by the imagination.[25] Now we have an account of what is supposed to stand behind that appearance: actual, albeit fractally complex, shapes or surfaces of bodies. The role of imagination, then, is not to create something in the mind that is not there, in the way that I might imagine a unicorn or hallucinate a pink rat. Rather, the imagination 'smoothes over its [the world's] rough edges and presents the world in experience as if it were a Cartesian geometrically uniform one'.[26] Therefore, unlike the case in which the mind perceives a certain corpuscular structure as redness or sweetness, what stands behind the appearance of shape is something of the same kind, albeit something that is infinitely more complex than it is perceived to be.[27]

Levey's response to the idealist interpreters is thus that they are mistaken in thinking that Leibniz believed there is something absurd or impossible about the idea of an infinitely complex shape. In fact, he claims, Leibniz was well aware of mathematical structures that display the properties of an infinitely complex shape, and he was also well acquainted with the emerging distinction between algebraic and transcendental curves. Thus, any interpretation of the shape argument that sees it as depending upon the premise that there could be no infinitely (or fractally) complex shapes is likely to be incorrect.

III. CRITIQUE OF SURFACE REALISM

As we have seen, previous commentators, both idealist and realist, have focused on whether Leibniz accepts or denies the possibility of an actual infinitely complex surface. In my view, this issue is not relevant to Leibniz's claims about the status of shape. Before explaining the way I think the argument should be understood, I wish to take a critical look at Levey's interpretation. On the interpretation I offer in the next section, Leibniz is decidedly not a surface realist, and any surface realist interpreter would need to employ Levey's general interpretative strategy of drawing a distinction between real and non-real surfaces, or between real and precise (determinate, fixed) shapes. Therefore, showing that there are problems with Levey's general interpretative strategy will lend support to my claim that Leibniz is speaking quite literally when he says that are no shapes.

The first problem with the surface realist interpretation is that it is grounded in a distinction that Leibniz never explicitly draws, namely, the distinction between surfaces that are shapes and surfaces that do not count

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[25]Levey, 'Leibniz on Precise Shapes ...', op. cit., 80.

[26]Ibid., 80.

[27]At least there is a sense in which they are of the same kind: they are both surfaces. Presumably, God could grasp or understand the fractal shape of the superficies of one of these supposed bodies. Levey, of course, wants to emphasize a sense in which they are not of the same kind, viz. the sense in which they are of different mathematical kinds.

as shapes. As Levey sees the distinction, the former are the (precise, determinate, fixed) shapes, which are surfaces describable in terms of seventeenth-century geometry; the latter are the fractal 'structures' or 'edges', which are surfaces that are too complex to be described in terms of seventeenth-century geometry. Although Levey never says that fractal surfaces do not count as shapes, and although he sometimes refers to these fractal surfaces as shapes, it is clear that his interpretation requires that he deny that they are shapes. As we have seen, Leibniz makes two remarks that would seem to contradict Levey's theory outright were it not for a distinction of this sort. In the quote above from 'Primary Truths', Leibniz states without any qualification that 'there are no shapes in things'. This remark seems to be an explicit denial that surfaces of any sort exist. Levey must, therefore, interpret 'shape' in such a way that it refers only to one kind of surface – the kind that does not actually exist. The second remark is that no shape can be 'appropriate for an infinite number of impressions'. As with the first text, Levey must deny that shape is synonymous with surface; for, Levey's view is that Leibniz thinks surfaces do reflect the infinite (indeed, fractal) complexity of the plenum.

A surface realist might argue, however, that although Leibniz does not explicitly draw the requisite distinction, however, he very often employs qualifiers such as 'precise', 'determinate', 'fixed', etc. when discussing shape, and this provides some evidence that Leibniz recognized a distinction between precise and non-precise shapes. Furthermore, in some contexts Leibniz only denies that there are shapes that 'a finite mind can grasp' (G II, 227; see also G VII, 563), and this too suggests that Leibniz believed there is a distinction between finite and infinitely complex shapes. Given, then, that Leibniz recognized mathematical structures that are not finitely describable, why is this not sufficient grounds for drawing the relevant sort of distinction?

Although it is possible that Leibniz intends to mark a distinction of this sort in his arguments concerning the reality of shape, there are several reasons to be sceptical. First, as we have just seen, Leibniz does not always qualify his claim that there are no shapes. His use of qualifiers such as 'precise' and 'determinate' could simply be intended to emphasize the point that despite the appearance of precise or determinate shapes there are actually no metaphysically determinate surfaces at all. Second, even if he is in some contexts denying that in nature there are mathematically precise, geometrically definable structures that a finite mind could comprehend, it does not follow from this that he believes there to be actual non-precise, non-geometrically definable structures that a finite mind cannot grasp.[28]

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[28]In one of the texts in which he denies the existence of shapes a finite mind can grasp, it seems clear that his claim is based on diachronic considerations; that is, he is making a point about the endurance of shape through 'the least space and time' (G VII, 563). The diachronic arguments, however, seem designed to undermine the possibility of shape no matter how complex; for the

Third, we need to be cautious about assuming from the fact that Leibniz recognizes the existence of fractally complex structures in the realm of mathematics that he takes these to be the sorts of structure that could be instantiated in nature. Leibniz is very careful to avoid confusing theoretical structures or idealizations with real entities or structures. For example, although he recognizes the utility of infinitesimal quantities, he denies their actual existence in nature. He also takes points, lines and surfaces to be mere abstractions, although he does not shy away from employing these types of entity in mathematical and geometrical reasoning. Moreover, he is fond of considering the structure of a plenum constituted of globes of ever diminishing size, even though he does not believe that the world is actually constituted of such entities.[29] Thus, without evidence that Leibniz is committed to the existence of fractally complex structures in nature, there seems to be good reason for scepticism about any interpretation according to which he is.

The interpretation also seems implausible when considered in the context in which the arguments concerning shape appear. There is no doubt that Leibniz's critical remarks about shape and motion are intended to undermine the Cartesian conception of body. Size, shape and motion are, after all, the sole modes of Cartesian body, and thus showing that there is something suspect about these modes would be in effect to show that there is something suspect about Cartesian extended substance itself. According to surface realists, however, there is nothing problematic about the existence of surfaces. They must maintain that Leibniz's criticism of Descartes is weaker than the claim that there literally are no surfaces. Levey's suggestion is that Leibniz's remarks about shape are, at least in part, intended to point out that actual shapes are infinitely more complex than Descartes would ever have thought, and that therefore, in thinking that corporeal nature can be described or understood in terms of traditional geometry, Descartes is mistakenly taking the finite, uniform shapes that we imagine or sense-perceive (both of which involve the faculty of imagination) as modes of real bodies in the plenum.[30]

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same considerations that show that a finitely complex shape could not exist for more than a moment would also show a fractally complex shape could not endure for more than a moment.
[29] See, for example, 'On the Plenitude of the World' (A VI, iii, 525).
[30] Levey, 'Leibniz on Precise Shapes ...', op. cit., 69. Whether or not Descartes is guilty of underestimating the complexity of the plenum, I think it is unlikely that he is guilty of 'mistaking the sensory appearances for reality' (ibid., 82); for he would agree that any sense-perceived or imagined shape of a particular body is going to involve the imagination to the extent that it involves abstraction from the infinite (or indefinite) complexity and continuously changing nature of the plenum, and that any sensed or imagined shape will necessarily be less complex than anything that actually exists in the plenum. Thus, we would agree that no representation of the way a part of the plenum actually is could be sufficiently complex to account for the actual extent of its complexity. For a discussion of idealization and micro-complexity in Descartes's physics, see Alan Nelson, 'Micro-Chaos and Idealization in Cartesian Physics', *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, 377–91.

Descartes may well be guilty of the main charge of underestimating the complexity of the plenum and thinking that the resources of seventeenth-century geometry are sufficient for an exhaustive description of corporeal reality.[31] However, it is hard to believe that this could be the full extent of the intended anti-Cartesian thrust of the shape argument. Certainly, these are important points, but they are disappointingly weak as criticisms of Cartesian metaphysics. In fact, they are so weak, it is not clear why Leibniz would feel a need to press them in his correspondences with Arnauld. They seem to make a merely technical point about the degree of complexity one mode of extension actually has, without challenging at all the idea that a plenum could be constituted by extension alone. In fact, as far as these criticisms are concerned, there is no reason at all to reject the view that the actual plenum consists of Cartesian extension. And there is evidence that Leibniz intends for the shape considerations alone to undermine the possibility of a plenum constituted of extension. In a 1686 letter to Arnauld, for example, Leibniz says:

> And indeed it can be said that *because of the actual subdivision of the parts, there is no definite and precise shape in bodies*. As a result, *bodies would doubtless be only imaginary and apparent, if there were only matter and its modifications*.
>
> (G, II 77 [AG 80])

This text makes it clear that Leibniz thinks that the lack of determinate or precise shape in bodies provides sufficient grounds for ruling out a Cartesian metaphysics of matter. On the face of it, the argument appears to depend on there being literally no shapes or surfaces, since otherwise it could not be concluded that Cartesian matter is fully imaginary or apparent. If we read it in this way, it is clear why bodies would be imaginary if only the modes of extension constituted body: one of the primary modes of extension is literally an appearance or construct of the imagination. If we read it as the surface realist would, the argument depends on the claim that the actual (indefinite or imprecise) shape or surface of a body does not count as a modification of extension.[32] The denial that there are precise shapes is supposed to imply that modes of extension, and thus bodies constituted of extension, are imaginary. I see no reason to think that some surfaces should

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[31]While I believe it is possible that Descartes is guilty of this charge, it is not obvious that he is. He is certainly aware that matter is infinitely or indefinitely divided and thus infinitely complex (Descartes, op. cit., 239); and there is little textual evidence that he thinks seventeenth-century geometry (plus temporality) could do anything more than describe idealized physical objects and events. This is not to deny, however, that Descartes conceived of the essence of matter in broadly geometrical terms, that is, in terms of spatial quantity.

[32]Levey, I assume, would read the argument as follows: there are no finite shapes (though there are fractally complex shapes); so, finite shape is imaginary; so, if there is only matter and its modifications, bodies are fully imaginary and apparent.

count as modifications while others should not; nor does Leibniz suggest a reason for restricting what counts as a modification in this way. More importantly, however, the argument interpreted in this way shows that Cartesian extension is impossible only under the condition that bodies are regarded as having finitely complex shapes. This does not undermine the possibility of a plenum of Cartesian bodies *tout court*. Indeed, all the Cartesian must do is grant that surfaces are more complex than they realized and their metaphysics of matter comes away unscathed. If, on the other hand, we take the more natural reading of this argument, according to which there is something problematic about shapes or surfaces of any sort, then we have a strong argument for the complete rejection of a plenum of matter and its modifications. Since undermining the Cartesian conception of matter as pure extension seems to be one of Leibniz's central goals in his correspondences with the Cartesian Arnauld, I believe the stronger interpretation is more likely to be correct.

Before leaving this argument, there is one more thing worth pointing out. The argument is not intended to have solely negative import; in fact, in most contexts in which the shape argument appears, Leibniz is appealing to the problems he sees with Cartesian extension as a way of providing some support for an alternative metaphysics. Specifically, the conclusions of the shape argument are intended to be part of a larger argument for the claim that we must recognize something else in the world in order to account for the reality of our phenomena.[33] The general line of reasoning, incorporating the argument we are currently considering, could be put as follows: there are no precise shapes; so, if there were only matter and its modifications, bodies would be merely imaginary and apparent; but they are not merely imaginary and apparent; thus there is more than matter and its modifications. Leibniz seems simply to assume that there must be some reality that lies behind our appearances, and so, since matter and its modifications are imaginary, we need to recognize something else to ground the reality of the phenomena. As it turns out, this 'something else' is some sort of immaterial principle – a substantial form, soul or entelechy. Unfortunately, it is impossible to infer what this additional element in our analysis should be on the basis of this argument alone. It is significant, however, that if Leibniz's point about shape is that there are literally no shapes or surfaces, that would give us a clue about the sort of thing that is required. What is needed is 'something lacking extension ... otherwise there would be no source [*principium*] for the reality of phenomena or for true unity' (C 523 [AG 34]). On the other hand, if what is ruling out the possibility of a Cartesian plenum is only that its bodies have finite surfaces, then the argument gives absolutely no indication of what this additional element must be.

The above criticisms provide, I believe, good evidence that Levey's interpretation of the shape argument faces significant challenges. Of course,

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[33]See, for example, G, II 98 and 119 [M 122–3 and 152–3].

there may be other possible surface realist interpretations, but it is hard to know what such an interpretation would look like. Surface realists seem to be in the following position: on the one hand, they cannot think that the shape argument has enough force to rule out surfaces *tout court*; on the other hand, they must interpret the argument in such a way that it is strong enough to show there is something unacceptable about the idea of shape or surface in a Cartesian plenum. These constraints are difficult to satisfy because it seems that Leibniz intends for the Shape Argument to be applicable to a plenum of any sort.[34] If this is correct, then it seems that realist interpreters must accept a view that is at least similar to Levey's in so far as it recognizes a distinction between the types of surface that do exist in a plenum and the types that do not. As I have tried to show in this section, however, there are serious problems with interpretations according to which Leibniz recognizes a distinction of this sort. Thus, on the assumption that there is a plausible anti-realist interpretation available, Leibniz's arguments concerning shape constitute a genuine challenge to realist interpretations of Leibniz's metaphysics in the 1680s.

IV. THE INDIVIDUATION OF SURFACES

I have argued that surface realist interpretations of the shape argument face significant challenges. One virtue of the reading that Levey defends, however, is that it offers an interpretation of the link between infinite division and shape that does justice to Leibniz's mathematical sophistication. It is on this point, I think, that previous anti-realist interpretations have failed. On Adams' interpretation, for example, the link between infinite division and lack of shape is via the implicit premise that Leibniz would have taken an infinitely complex shape to be 'an absurd and impossible monstrosity'.[35] Although Sleigh thinks that Leibniz has different considerations in mind, his interpretation of the argument also depends on the assumption that a shape of infinite complexity is impossible. In his view, Leibniz denies the possibility of shape on the grounds that 'given the actual infinite division of matter, whatever shape we assign to [any material object]

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[34]Leibniz never explicitly restricts the applicability of his argument to a Cartesian plenum. Rather, his reasoning is expressed in a way that suggests he is making a more general claim about the status of shape in any plenum in which there is motion. For example, in 'Primary Truths' he says simply '*There is no determinate shape in actual things*, for none can be appropriate for an infinite number of impressions' (C 522 [AG 34]). Even when the Cartesian conception of matter is his explicit target, his arguments against shape are quite general. For example, to Arnauld he says that 'the shape itself, which is of the essence of a finite extended mass, is never exact and strictly specific *in nature*, because of the actual division ad infinitum of the parts of matter' (G, II 119 [M 152]; emphasis added). Levey would agree that Leibniz intends the conclusions about shape to be applicable to a plenum of any sort, since he reads Leibniz as making a point about actual shapes in a Leibnizian plenum.

[35]Adams, op. cit., 230.

x, it is not complex enough to take into account the influence ... of infinitely many other bodies'.[36] While this provides a little more detail about why Leibniz might think an infinitely complex shape is impossible, it still depends on the assumption that there could be no infinitely complex shape – whether or not we could 'assign' it. Both of these views thus depend on seeing Leibniz as relatively unsophisticated with respect to the infinite in this period of his career. Levey, however, makes a convincing case that Leibniz was actually quite familiar with mathematically infinite structures very early in his career – structures with the very same characteristics that both Adams and Sleigh think make them impossible.[37] This is not to say, of course, that Levey successfully demonstrates that Leibniz thinks these structures are instantiated in nature. However, it does provide strong evidence that Leibniz thinks the idea of an infinite structure is neither contradictory nor absurd. It thus seems to be a constraint on any adequate anti-realist interpretation of the shape argument that it reflects Leibniz's deep understanding of the mathematically infinite.

In this section, I offer an anti-realist interpretation that both takes into account Leibniz's mathematical sophistication and amounts to a deep critique of the Cartesian metaphysics of matter. According to this alternative interpretation, the problem to which infinite division gives rise is not that it results in impossibly complex surfaces but rather, that it results in a type of fluidity in the plenum that makes the metaphysically determinate individuation of surfaces impossible. If the individuation of surfaces is impossible, it follows that surfaces are wholly phenomenal; that is, they only exist in perception or imagination. Of course, in thinking about a plenum of matter in motion, it may be natural to begin with ideas of bodies and their surfaces, and in fact there are things Leibniz says that encourage us to think this way. However, as I shall suggest in this section, Leibniz's view is that if we push on these ideas a little, it becomes clear that it is difficult to make sense of the existence of determinate surfaces in a plenum. Because my interpretation depends on seeing what happens when we put pressure on realist assumptions, it will be instructive to introduce my view in explicit contrast with the surface realist version of the argument. Hopefully, this will help clarify certain assumptions the surface realist attributes to Leibniz which I believe Leibniz would avoid making.

Let us begin with the first premise of the argument: (1) matter is actually infinitely divided. There is no doubt that Leibniz is committed to this claim, and there is general agreement among commentators about why he thinks it is true. However, there is room for disagreement about what is implied by the claim and how we are supposed to conceptualize an infinitely divided plenum. The reasoning Leibniz offers for (1) is that motion in a plenum is only possible if there is infinite division, and so, given that there is a

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[36]Sleigh, op. cit., 113.
[37]Levey, 'Leibniz on Precise Shapes ...', op. cit., 86–7.

genuinely extended plenum of matter with parts that are in motion, there must be infinite division.[38] On the face of it, this line of reasoning appears to take for granted that a plenum exists, which in turn might be taken to support a realist reading of the shape argument; after all, if the argument assumes an extended plenum with parts that are in motion, it is hard to see how Leibniz could reach the conclusion that there are no surfaces, since a part is just a portion of matter that is delineated by its surface. It is important, however, to keep in mind the conditional nature of the argument. Certainly, Leibniz thinks that there are things that must be the case *if* genuinely extended matter exists. It may, though, turn out that there are problems with this assumption in the end. Indeed, I think the argument can be seen as a sort of *reductio* of the assumption that matter exists. Of course, the correctness of this interpretation depends on the much larger issue of whether Leibniz's metaphysics in the 1680s was idealist, an issue which is beyond the scope of this paper.[39] Nevertheless, if my criticisms of the surface realist interpretation are correct and the argument is better understood as supporting an anti-realist view of shape, that should provide at least some motivation for thinking that the argument is best interpreted as a *reductio* of the assumption that there is matter, for it would seem that realism about divisions in an extended plenum would entail realism about determinate surfaces.

Given the assumption of an infinitely divided plenum, we now need an account of the inference from the claim that (1) matter is infinitely divided, to the claim that (2) there are no determinate shapes. As we have seen, previous commentators have explained this inference by thinking about what would have to be true of a particular body in an infinitely divided plenum. Idealist interpreters have seen Leibniz as arguing that the surface of such a body would have to have, per impossible, an infinitely complex shape; and they take this to be a *reductio* of the assumption that there are bodies with metaphysically determinate surfaces in the plenum. When surface realists ask us to consider what would have to be true of a particular body in the plenum, however, they are of course assuming that Leibniz thinks there actually are bodies in the plenum that are neatly individuated and have metaphysically determinate surfaces. Is this assumption warranted? Does it follow from the original assumption, namely, that matter exists? Presumably Levey, at least, thinks it does, since he does not attempt to justify our 'taking' a body for analysis.[40] I think it is quite natural to

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[38]See fn. 9.

[39]There has been a great deal of attention paid to this issue in the last two decades. See Garber, 'Leibniz and the Foundations . . .', op. cit. for a defence of realism about corporeal substances, and Adams, op. cit. for an idealist response. See also, R. M. Adams *et al.*, 'Symposium on *Leibniz: Determinist, Theist, Idealist*, by Robert Merrihew Adams', *Leibniz Society Review*, 61– 125. For a summary of the current state of the debate, see Paul Lodge, 'Garber's Interpretation of Corporeal Substance in the ''Middle Years''', *The Leibniz Review*, 1–26.

[40]Levey begins by asking us to 'take as a simplified case of a body a finite line segment' (Levey, 'Leibniz on Precise Shapes . . .', op. cit., 76).

think it does, given the way Levey is thinking about the structure of the plenum. As we have seen, he thinks the image of the tunic is especially revealing. What it reveals, he thinks, is that the plenum, and every part of the plenum is to be understood as 'infinitely *broken up* into separate parts each of which is moving with its own motion ...'.[41] I find this a peculiar thing to draw from this particular passage.[42] However, Leibniz says other things that have suggested to scholars that we are to think about the structure of matter in just this way. For example, in a letter from 1669 Leibniz says that the parts of matter are discontinuous and have separate boundaries (A, VI, ii, N54 [RA 337]). In his more mature works he often characterizes matter as discrete, or as having determinate parts. There is a great deal to be said about these texts, and I will make some brief remarks about them later in the paper. What is important for now is that this characterization is very conducive to conceptualizing the plenum as broken up into determinate parts. This in turn is very conducive to thinking that the parcels of matter into which the continuum is broken up have metaphysically determinate surfaces, as well as to thinking that at least at some level of analysis, bodies are somewhat neatly individuated from one another.

As natural as it may be to think about the plenum in this way, I think it is not so obvious that the assumption that matter exists justifies the claim that there are particular bodies with metaphysically determinate surfaces. In fact, it seems to me that Leibniz thinks there are consequences of infinite division that undermine the existence of determinate surfaces in a plenum. There are different ways to arrive at this point, but we can begin by noting that there is an alternative way Leibniz talks about the plenum that seems to invite a different way of conceptualizing its structure. In a paper in which Leibniz presents the shape argument, and which was written approximately ten years after the tunic passage, Leibniz characterizes the world as essentially fluid, rather than broken up:

> The whole world is one continuous fluid [*fluidum continuum*], whose parts have different degrees of tenacity, as if someone were to make up a liquid out of water, oil, liquid pitch and similar other things variously stirred together.
> (A, VI, iv, 312 [RA 331])[43]

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[41]Ibid., 76.

[42]Although it is not entirely clear what Leibniz intended to express with the tunic analogy, I would have thought that at least part of the point of the analogy is that rather than being broken up into discrete parcels, parts of the continuum are better understood as being continuous with one another, as flowing into each other in the way that the two parts of a folded tunic flow into one another. At the very least, if Leibniz wanted to make the point that matter is everywhere broken up, the distinction he draws between a folded tunic and grains of sand seems unfortunate, for it seems that grains of sand are much better described as broken up than are folded tunics; certainly, it seems unlikely anyone would be inclined describe a folded tunic as broken up into parts. Of course, there are other things Leibniz might be trying to express with the analogy, such as that there is never a resolution of matter into points.

[43]See also, from the same text, RA 313, 323 and 327.

This characterization of the plenum as essentially fluid is no anomaly. In fact, we find that it plays an important role in Leibniz's settled views on the physics of impact.[44] Furthermore, as late as the period of the *New Essays*, we find him saying that fluidity is the 'fundamental condition' of the material continuum (RB, II, xiii, 23). As I shall argue, this conception of the plenum has important implications for determinate surfaces. For now, I merely want to point out that the claim that the plenum is essentially fluid suggests a very different picture of the structure of matter. If we start with a conception of matter as chopped into discrete bits, it is much easier, for example, to assume that there are individuated bodies than if we start by thinking of it as a fluid. If, on the other hand, we are thinking of the plenum as a fluid and the surface realist asks us to think about what is going on along the surface of a particular body, we might wonder: where in the infinitely complex, essentially fluid plenum are the metaphysically determinate surfaces supposed to be? How does the surface realist expect us to get started? This of course is not an argument that there is an inconsistency between fluidity and the existence of determinate boundaries; but it is worth noting since it suggests that we should be careful to avoid relying too heavily on a picture of the plenum as discrete when we are considering whether the existence of a plenum is sufficient for their being metaphysically determinate surfaces. With that in mind, let us now take a closer look at the relation between fluidity and determinate surfaces.

Leibniz thinks that the fluidity of the plenum follows from its actual infinite division, and he also thinks that it is closely connected to the correct account of bodily cohesion. The divisions in the plenum, as we have seen, result from the infinite variations in the motions of its parts. Any particular parcel of matter will thus be composed of smaller parts that have motions which vary from one another; but the parts will also have some motion in common, and Leibniz thinks that this provides an account of cohesion or 'tenacity' in body. To the extent that a parcel of matter has parts with motions that are similar to one another, that parcel will have a degree of cohesion or 'tenacity'.[45] On the other hand, to the extent that the parcel has parts with motions that differ from one another, the parcel will have a degree of fluidity or flexibility. It is thus a consequence of his claim that matter is actually infinitely divided that any parcel of matter will have some degree of fluidity and some degree of cohesion.[46] This account of cohesion is especially important for Leibniz

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[44]See, for example, his 1695 'A Specimen of Dynamics' in which he argues that no matter how small a body is, it will have some degree of elasticity in virtue of its being 'permeated by a fluid even subtler than it is' (AG 132–3).

[45]See A, VI, iv, 312 [RA 323–33] for Leibniz's account of cohesion and fluidity. See also the editor's introduction to RA for a clear discussion of this account (RA lx).

[46]   Therefore it must be said that no point can be assigned in the world which is not set in motion somewhat differently from any other point however near to it, but, on the

because there is reason to believe that in his later work on the continuum (beginning around 1676) he assumes a Cartesian account of the individuation of body according to which a body is a parcel of matter whose parts move together. He assumes, in other words, that the conditions that must be satisfied in order for a quantity of matter to constitute one body are the very same conditions that must be satisfied in order for a quantity of matter to constitute a coherent thing.[47] Although he is not explicit about this account of individuation in 1676, Leibniz offers a clear statement of the account in an early text (1672–3):

> It is manifest that a body is constituted as definite, one, particular, distinct from others, by a certain motion or endeavour of its own, and if it is lacking this it will not be a separate body, but [there will be] one continuous body cohering with it by whose motion alone it is moved. And this is what I have said elsewhere, that cohesion comes from endeavor or motion, that those things that move with one motion should be said to cohere with one another.
> (A, VI, iii, 2 [RA lix–lx])

According to this account of individuation, a parcel of matter is a body if and only if it has parts that cohere or have similar motions, relative to the motions of the bodies that surround that parcel; that is, a body – one distinct body – just is a cohering part of the plenum. In the case in which it is lacking this agreement of motion in its parts, it is simply continuous with the matter which surrounds it.

This account of individuation in terms of cohesion has interesting consequences. As we have seen, Leibniz thinks that actual infinite division entails that any parcel of matter must have some degree of cohesion and some degree of fluidity. Lacking any cohesion, a parcel of matter would be a perfect fluid (which Leibniz thinks is impossible); and lacking any fluidity, a parcel of matter would be a perfectly hard atom (which Leibniz also thinks is impossible). If every parcel of matter has some degree of fluidity, it follows that coherence is a matter of degree.[48] If coherence is not all or nothing, it would seem to follow that the individuation of body, understood in terms of the common motion of its parts, is not strictly determinate either. As we have seen, coherence and individuation have the very same conditions. A body is a parcel of matter whose parts cohere in such a way that they are transferred together; but fluidity guarantees that it will never be the case that all the parts of a supposed body will be transferred together; for any parcel of matter is to some extent 'permeated by a fluid even subtler than it is'

> other hand, that no point can be assigned that does not have some motion in common with some other given point in the world; under the former head, all bodies are fluid; under the latter, all are cohering.
> (A, VI, iv, 301 [RA 291])

[47]I concur with Richard Arthur's interpretation here (RA lix–lxi).
[48]This is noted by Arthur (RA lx).

(AG 133), a fluid with parts that do not share to the same extent the common motion of the other parts. This will be true not only of the body we start with but also of the infinite parcels of matter that lie along the edge of the original body. Thus, there will necessarily be regions along the supposed surface of a body which are continuous with the fluid outside the body and which are not transferred with the body as it moves from the vicinity of some set of bodies to the vicinity of another. This is also going to be true to a certain extent of the surface that appears to remain after we have taken into account the fluidity at some higher level of analysis.[49] Given this, it would seem to follow that there is no fact about the world in virtue of which determinate boundaries among bodies exist. Rather, surface is always going to be phenomenal or imaginary, not because we can never perceive or imagine the true metaphysically determinate surface, as the realist would have us believe, but because any purported surface will eventually yield to fluidity at some level of analysis. This is something that Leibniz seems to recognize about the determinate individuation of body. After pointing out that any parcel of matter has a certain degree of fluidity and a certain degree of cohesion, he says the following: 'But to the extent that a common or proper motion is more or less observable, a body is *called* one solid, or a separate body, or perhaps even a fluid' (A, VI, iv, 301 [RA 291]; emphasis added).

Bodies cannot be strictly individuated from one another because of the essential fluidity of the plenum. This does not rule out that (perceptually discriminated or individuated) areas of the plenum could be relatively coherent and move around together. When we see a rock, for example, we observe some common motion among its parts and for that reason call it 'one' body. However, as Leibniz is well aware, a rock is much more like a cloud than like an atom, and if we consider the nature of the plenum we will see that the individuation of the body is more perceptual than metaphysical.

Another way to see the consequences that fluidity has for metaphysically determinate shape is to start with a supposed body and consider the implications of infinite division for its having a metaphysically determinate surface. Let us consider or 'take' a body in the plenum. Since any body in the plenum can be thought of as infinitely divided into smaller bodies, a macro-object ought to be an acceptable model for one of the micro-bodies that constitute the macro-body. Let us consider, therefore, a parcel of matter that has been individuated in sensory perception; say, a billiard ball. A surface realist would say that despite whatever appearances to the contrary, the surface of this body is infinitely variegated as a result of the fact that the body is actually composed of smaller bodies, each of which has

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[49]The idea of a surface 'appearing' a certain way can be understood either perceptually (e.g. in terms of the way a creature with more acute sense organs would perceive the body) or as part of an imaginary representation of a body at a particular level of analysis.

a slightly different motion from the others.[50] Since the same will be true for all of the bodies that compose the billiard ball, there will be infinite variations or bends in the surface of the billiard ball, no matter what level of detail we consider. Importantly, at no point in the analysis will the surface fail to be perfectly individuated from what is outside the body.

This is a natural way of thinking about the situation. It is quite common for us to experience an object at a distance as having a continuous shape with very little complexity only to find that on closer examination it is more complex than it originally appeared. If we look at the surface through a magnifying glass, we find more and more complexity in the surface as we increase the magnification. Leibniz makes this point explicitly in the letters to Arnauld when he says things such as that we will never find 'a shape without inequalities, nor a straight line without curves intermingled, nor a curve of a certain finite nature unmixed with some other, and in small parts as well as large' (G, II 119 [M 152]). However, as we have seen, this cannot be the end of the story if we are thinking carefully about the implications of infinite division. Given the essential fluidity of the plenum, we would find that eventually the determinate (albeit, ever-increasingly complex) shape of our body begins to lose its determinacy, and it begins to be quite unclear what ought to count as part of the surface. In fact, it would eventually become unclear what ought to count as a part of the body, whether it is on the surface or otherwise; for again, all bodies are to some degree porous and permeated by relatively fluid matter; and the explanation of this is that all matter is infinitely divided by motion into ever smaller parcels of matter, some of which have a motion that is not in accordance with the other more coarse parts of the body. This essential fluidity is not simply a feature of what is going on inside and outside some metaphysically determinate shell or surface of the body. It is also a feature of the bodies (i.e. the fluid) that lie along the supposed superficies of the body. Given this, we might ask, are those bodies that are relatively fluid with respect to the more coarse parts, themselves part of the body? It seems as if the answer ought to be 'no' because the fluid does not have a common motion with the parts of the body in virtue of which the body is said to cohere, although some of the fluid may sometimes be transferred with the body if it is 'caught' in the interior. If the answer is in fact 'no', then it seems that we are going to lose more and more of the assumed determinate shape to fluidity the deeper we go in our analysis. On the other hand, if the answer is 'yes', then there must be some principled account of the distinction between the fluid that belongs to the body and the fluid that does not. It is not clear, however, what such an account would look like if individuations are grounded in motion.

There is yet another way of seeing the central point here. According to Leibniz and Descartes, all bodies in a plenum are continuously losing and

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[50]Motion is required for the individuation of body in a plenum, because there cannot be individuation by separation.

acquiring parts (as a result of parts being shorn off other parts as they squeeze through vortices). At any moment, along the surface of a body there will be some smaller parcels of matter that are on the way to becoming part of the body, and others that are on the way to becoming separate from the body. If surfaces are metaphysically determinate, there must be some non-arbitrary reason for saying of some parcels of matter that they had made it in (or out) and others had not. However, given the infinite micro-complexity in all parts of body, it is not clear what that could be.[51] And the fact that cohesion and common motion are matters of degree makes it even more difficult to think that there could be a fact of the matter about when something begins or ceases to be part of some parcel of matter or its surface.[52]

Given Leibniz's assertions about the essential fluidity of matter, it seems to me that surface realism is a view that depends on an untenable and overly abstract conception of a body in a plenum. It grants that there is infinite complexity of motion both within and without a particular body, but it assumes that a body at any moment of its existence possesses a metaphysically determinate, shell-like surface which separates the relatively fluid matter surrounding the body from the relatively coherent matter within the body and which reflects the infinite variations in the motions of the surrounding and contained matter. It is this picture that allows the realist to assume that no matter how much internal variation there is in the motions of the parts of the body, the whole thing could be transferred together and thus *be* one body with a metaphysically determinate surface. However, as we have seen, the idea that there could be a perfectly determinate shell could only be arrived at by abstracting away from the infinite complexity in the motions of the bodies at the interface between the more coherent and the more fluid parts of the plenum. In fact, it seems to me that the only way there could be a metaphysically determinate surface is if a body were at any moment of its existence like a perfectly hard atom, with no variations in the motions of any part of the body. Leibniz seems to be making this point when he says to Arnauld that 'one will never be able to fix on a certain precise surface in a body as one might do if there are atoms' (G, II 119

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[51]In 'A Specimen of Discoveries' Leibniz asks an extremely suggestive question that seems relevant to this point:

> Is one body never separated from another without a connection remaining, a 'trail of smoke,' which is subtler and more inefficacious the greater the distance and time of separation, or the less the body's parts are agitated – just as all things leave behind some traces and odors, as they pass by.

(A, VI, iv, 312 [RA 329])

[52]Since the surface realist must grant that the bodies along the superficies move in motions that are not perfectly similar, they would need a principle which links membership in the set of points on the surface to similarity in motion with one another and with some set of other points in the interior of the body, and dissimilarity with the motions of the points outside the body. Attempting to provide such a principle would seem to me clearly fraught with difficulties.

[M 152]; see also AG 133). The reason that an atom would be suited to having metaphysically determinate surfaces is that a perfectly hard body will be one which has no degree of fluidity. Such a body would not be porous in the way bodies in a plenum are, it would not have parts with motions that are radically dissimilar from other parts, and it would not be permeated at every level of analysis with more fluid matter. In short, there would be a strict discontinuity between the surface of an atom and the surrounding void or fluid. The point of Leibniz's mentioning as part of the analogy in the 'Specimen of Discoveries' that the oil, water, tar pitch, etc. are stirred together is to highlight the fact that the fluid matter, in this case water, permeates the less fluid matter such as the oil, tar pitch, etc. If this is the case, then it seems clear that drawing sharp boundaries between the stuffs in the mixture would be impossible.

At this point let us consider what has been shown so far, and then consider some possible worries about my interpretation. Recall that we began by assuming the existence of matter. Leibniz thinks that there are metaphysical reasons for thinking that if there is matter at all, the world is completely full. Since motion in a plenum requires infinite division, then on the assumption that there is motion, there is infinite division. The next step is to assume, for the sake of *reductio*, that there are individuated bodies with metaphysically determinate surfaces. Consideration of Leibniz's insistence that fluidity is the fundamental condition of the plenum reveals that not only will any apparent or imagined surface be more complex than it appears to be, but further, that any supposed surface will fail to be metaphysically determinate; that is to say, at some level of analysis, what seemed to be a perfectly determinate, if ever increasingly complex, surface will literally disappear or yield to fluidity. This will be true not only for the macro-bodies of our perceptual experience, but also for the infinite micro-bodies that constitute larger bodies. The assumption that there are bodies with metaphysically determinate surfaces has thus been shown to be false in a way that does not depend on denying that Leibniz recognizes the possibility of infinitely complex structures.

Is this tantamount to showing that there is no genuinely extended matter at all? At the very least, this consequence should be troubling to a realist about a genuinely extended plenum. If there is an extended plenum, there must be some account of the elements out of which it is composed; and usually realist interpreters understand Leibniz to be proposing that realistically construed corporeal substances (i.e. composites of form and matter) are these elements. It is important to keep in mind that Leibniz's argument that there are no surfaces is not conditional on a particular metaphysics. In other words, Leibniz's argument is not that *if* there are no substantial forms in matter, there are no determinate surfaces. It is simply that given infinite division (something to which he is steadfastly committed) there are no surfaces or shapes.[53] Indeed, the fact that there are no

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[53]As I noted above, anyone who adopts Levey's general interpretative strategy will agree that the shape argument is meant to be quite general, since this strategy involves drawing a

determinate surfaces is supposed to provide some motivation for introducing something akin to form into the metaphysics of matter. Thus, even if there are composite or corporeal substances in the world, these entities too will be without metaphysically determinate surfaces. If they lack determinate surfaces, it is hard to see how corporeal substances could solve the problems of individuation and unity to which infinite division gives rise. In fact, Leibniz would probably deny that entities like this could be candidates for substances, since he believes that substances are completely determinate.[54]

One might think, however, that showing that this sort of indeterminacy exists in a plenum is not sufficient for showing that there is no extended plenum, since one might think it conceivable for there to be an infinitely divided plenum in which there are simply no metaphysically determinate surfaces. For example, one might think about the plenum as containing bodies that are more like currents in the ocean than like billiard balls. It seems to me, however, that there is a serious worry we might have about such a plenum: it is unclear how we are to understand division in a plenum if the objects into which a parcel of matter is divided do not have surfaces. Actual division seems to imply, or at least many commentators take it to imply, metaphysically determinate partitioning of the plenum into bodies with metaphysically determinate surfaces. If it does, then infinite division itself has been shown to be problematic, for whatever can be said about the indeterminacy of the surfaces of billiard balls or oil corpuscles can also be said about any supposed discrete micro-body, no matter how far down we go in our analysis. If I am right about this, then the problem with shape is not that at some extremely deep level of analysis we are entitled to perfectly partitioned bodies with metaphysically determinate surfaces but at some higher level these micro-bodies wreak havoc on the individuation of surfaces. Rather, it is a problem that arises for determinate partitioning at any level of analysis. Of course, there may be some other way to understand what Leibniz means by infinite division that does not have these implications. However, short of a plausible alternative way of conceiving of division, it appears that in so far as the existence of matter implies infinite division into discrete parts, Leibniz's argument can be seen as a *reductio* of the very existence of genuinely extended matter, and not just the existence of metaphysically determinate surfaces in the plenum.[55]

distinction between precise or fixed shapes and actual (Leibnizian) surfaces. See fn. 33 for textual evidence that Leibniz thinks the argument is not restricted to any particular type of plenum.

[54]'Nothing is indefinite in actual things' (G, II 282 [PL]; see also A, VI, iv, 312 [RA 305]).

[55]The claim here is not that there is something incoherent about the idea of infinite division or infinite partitioning per se, but that there is something problematic about a metaphysics of matter in which the plenum is infinitely divided by motion and individuation of body is understood in terms of motion.

The shape argument thus has quite radical consequences. However, I think it would be a mistake to assume that Leibniz intends to highlight these consequences in the texts in which he presents the argument. In the Arnauld correspondences, for example, Leibniz uses the shape argument primarily to convince Arnauld that Cartesian bodies cannot be substances. Given that despite several attempts Leibniz cannot even convince Arnauld that there are problems with the Cartesian conception of matter, it is not surprising that Leibniz keeps these consequences to himself and argues for the more modest claim that if there is any reality in matter it must be due to the existence of immaterial principles of unity such as forms, entelechies or souls. What would be surprising, however, is if Leibniz failed to recognize the deeper implications of his own thinking about the plenum. It would also be surprising if his views about shape and motion did not play an important role in his movement in the direction of an idealist, monadological metaphysics.

Before making some brief concluding remarks, I would like to consider two prima facie objections one might have to my interpretation. First, one might worry that in so far as the argument as I interpret it seems to rule out the possibility that there are corporeal substances, it must be too strong, since Leibniz spends a great deal of time discussing corporeal substances in this period and sometimes suggests that they are necessary for the reality of matter. Second, one might object that the interpretation seems inconsistent with other texts in which Leibniz suggests that matter is discrete or has determinate parts.

Corporeal Substance: Leibniz's talk of corporeal substances has been the subject of intense debate over the last few decades. Some commentators have argued that in the 1680s Leibniz was a realist about corporeal substances, whereas others have argued that despite his talk of corporeal substances, Leibniz's ultimate metaphysics in this period was idealist in nature.[56] More recently, some scholars have arrived at the conclusion that at least in the 1680s Leibniz did not have a settled theory about corporeal substances.[57] Given this significant disagreement about Leibniz's views on corporeal substances, it is hard to know how to assess the charge that my interpretation makes the argument too strong because it does not allow for the existence of such substances. Certainly, my interpretation is inconsistent with (or at least in tension with) a realist interpretation of corporeal substance, and so if Leibniz is a realist about corporeal substance, then my reading is likely to be false.[58]

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[56]Leibniz characterizes corporeal substances as composites of form and matter. The most prominent realist interpretation is offered by Daniel Garber in his 'Leibniz and the Foundations of Physics ...', op. cit. For idealist interpretations of Leibniz's metaphysics in the 1680s, see Adams, op. cit. and Sleigh, op. cit.

[57]See, for example, Daniel Garber, 'Leibniz and Idealism', in *Leibniz: Nature and Freedom*, edited by J. Cover and D. Rutherford (Oxford: Oxford University Press, 2005): 95–107, and Donald Rutherford, 'Simples and Composites' (in draft).

[58]A 'realist interpretation' of corporeal substances is one according to which the substances are genuinely (mind-independently) spatially extended.

However, there is no consensus among commentators that this is in fact his view, and my interpretation is consistent with alternative ways of conceiving of corporeal substance. For example, nothing about my reading of the shape argument implies that Leibniz must deny the existence of, say, collections of immaterial entities that bear a special relation to a soul or form; and there is nothing about my interpretation that implies that Leibniz cannot retain a limited kind of realism about matter, according to which it is a well-founded appearance (or alternatively an infinite collection of immaterial substances). Furthermore, my reading is consistent with an interpretation according to which Leibniz simply does not have a settled view about corporeal substances in the 1680s. Of course, I cannot argue here for a particular view about Leibnizian corporeal substances. However, it seems to me that the correct interpretation will be one that is informed by Leibniz's views on the modes of extension, and especially his views on shape. As I have argued, there is a very strong case to be made for the inadequacy of surface realist interpretations, and there is good reason to think that Leibniz saw serious problems for the determinate individuation of surfaces in an infinitely divided plenum. This, it seems to me, ought to count as evidence against realism about corporeal substances and in favour of an idealist or immaterialist analysis of body.

The Plenum as Discrete or Determinate: there is no doubt that at various points in his career, Leibniz says things that suggest that he thinks matter is discrete, or discontinuous or determinate; and this has led several commentators to develop interpretations of Leibniz's views on matter that seem flatly inconsistent with my interpretation according to which fluidity undermines the determinate partitioning of the plenum into discrete parts. A careful examination of those views is beyond the scope of this paper. Nevertheless, I shall make a few brief remarks in defence of my interpretation. First, Leibniz says a variety of things in the early period of his career (roughly the 1670s and early 1680s) about the structure of matter, some of which is certainly suggestive of a view of the plenum as discontinuous or discrete. Renewed interest in texts from this period has led some scholars to develop illuminating interpretations of Leibniz's views on matter and motion.[59] However, it seems to me a mistake to assume that what Leibniz says in these early writings reflects his settled views about matter. After all, between 1669 and 1676 Leibniz recognizes a variety of different implications of the claim that matter is actually infinitely divided,

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[59]I have in mind here, especially, recent work by Richard T. Arthur and Samuel Levey. See Richard T. Arthur, 'Cohesion, Division and Harmony: Physical Aspects of Leibniz's Continuum Problem (1671–1686)', *Perspectives on Science*, 6 (Spring/Summer 1998) Nos 1 and 2: 110–35; Samuel Levey, 'Leibniz on Mathematics and the Actually Infinite Division of Matter', *Philosophical Review*, 107 (January 1998) No. 1: 49–96; Samuel Levey, 'Matter and Two Concepts of Continuity in Leibniz', *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, 94 (May 1999) Nos 1–2: 81–118.

and his views about the continuum vary.[60] Given this, it is not clear why we should think that what Leibniz says about matter in 1676, for example, that its structure is analogous to a tunic, reflects his views about matter in the mid-1680s and later. Even if we grant that the point of the tunic passage is to show that matter is broken up into discrete parts we need to be careful about assuming that this is Leibniz's view of the structure of matter in the 1680s, especially given that he does not return to the tunic analogy, nor does he mention discontinuity or discreteness in these later texts. What we do find in the 1680s discussions of matter is something quite different, namely, an emphasis on the fluidity of the plenum; and as I have suggested, the account of the plenum as fundamentally fluid has important implications for determinate surfaces.[61]

One might object, however, that although the talk of matter as being discrete and having determinate parts is not in evidence in the 1680s, it returns in the 1700s in Leibniz's account of the distinction between actual quantities and ideal quantities such as space and time.[62] Again, I think it is a mistake to assume that Leibniz's talk of discreteness and determinacy of parts in the 1700s means the same thing as it does in his 1670s writings on the continuum. In fact, at least with respect to the notion of 'discreteness', there is a great deal of evidence that in the 1700s Leibniz is not making a point about the structure of an extended plenum at all. Nevertheless, it is important to consider whether Leibniz's mature claims about matter are consistent with my interpretation of the shape arguments, for I am arguing for a greater deal of continuity between Leibniz's views in the 1680s and his more mature, idealist views than most realist interpreters. It would thus look bad for my interpretation if Leibniz is saying things about matter in the 1700s that are inconsistent with an anti-realist view about shape.

One important difference between these later texts and Leibniz's writings on matter from the 1670s is that it is fairly clear that Leibniz's metaphysics is idealist in the sense that the ultimate constituents of the world are simple substances or monads. He does not, however, want to deny the reality of

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[60]Arthur does a nice job of tracing Leibniz's varying thoughts through this period (RA xxxii–lxi).

[61]I do not wish to claim that Leibniz gives up discreteness in favour of fluidity in this period, nor that he thinks the two notions are incompatible ways of characterizing the plenum. Furthermore, I am not making any claims about what the 'correct' account of Leibniz's material plenum is. My claim is merely that Leibniz is aware of serious difficulties that infinite division, and the fluidity that results from it, raise for the existence of determinate surfaces and the individuation of bodies. Certainly, in the mid-1670s Leibniz wants it to turn out that there are individuated bodies, and in fact seems to assume that there are bodies that 'take some shape for some time, and are transformed' (A, VI, iii, 78:555 [RA 185]). However, by the 1680s, I believe, he is worried about the fact that infinite division seems to leave little metaphysical grounding for these sorts of determinate individuations. How Leibniz resolves this difficulty is, of course, closely connected to the much larger issue of whether Leibniz's 1680s ontology is realist in character.

[62]G, IV 562–4, 568–9; G, II 268–9 [AG 178], 278–9, 282 [AG 185], 336 [LR 93], 379 [LR 141].

matter in this period; rather, he thinks of it as a well-founded phenomenon. In so far as it is founded in or results from monads, it is real, but its reality is completely derivative from the simple substances from which it results. In the texts in which he calls matter discrete and determinate, Leibniz is explicating a distinction between ideal quantities, such as space and time, and actual or well-founded things, such as body and duration. The fundamental distinction, he claims, is that ideal quantities are continuous whereas actual quantities are discrete. It might be tempting to assume that when Leibniz says that matter is discrete, he means that matter is chopped up into determinate, individuated bits as a result of divisions, since Leibniz often says that matter is discrete in contexts in which he also makes the claim that the parts of matter are determinate. However, I think it is doubtful that Leibniz thinks these claims are equivalent, for Leibniz never, at least in the texts of which I am aware, explicitly equates discreteness with having determinate parts.[63] Usually when Leibniz refers to matter as 'discrete', it is clear that he means that it is the result of an infinitude of units, or monads, or simple substances – entities which are not, strictly speaking, parts of matter.[64] In a January 1706 correspondence to de Volder, for example, Leibniz says the following: 'In actual things, there is only a discrete quantity, namely, a multitude of monads or simple substances' (G, II 282 [AG 185]; see also G, VII 562; G, II 278–9). These simple substances, in fact, are presupposed by infinite division into parts, since 'without change in simple things, there would be no change in things at all' (G, II 252 [PL]). Therefore, the claim that matter is discrete does not seem inconsistent with anti-realism about surfaces.

If there is a tension between my interpretation and these later texts, then, it must arise as a result of Leibniz's saying that matter has determinate parts which are 'actually assigned in a certain way' (G, II 268 [AG 178]). After all, this would seem to show that Leibniz thinks infinite division is consistent with there being determinate parts. However, I do not think there is a genuine conflict here. On the one hand, if we assume the existence of a genuinely extended plenum and then think about what would have to be true of such a plenum, I think it would be right to conclude that any level of analysis would reveal infinite determinate qualitative differences, and that these differences would be assigned in one way rather than an infinite number of other possible ways. Any set of points in the plenum, for example, would bear determinate relations to one another as we track them over time. This is simply a consequence of actual infinite division via motion. On the other hand, there is evidence that in this period Leibniz does

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[63]In at least one text, Leibniz seems to make clear that they are separate ideas: 'Matter is not continuous but discrete, *and* actually infinitely divided ...' (G, II 278 [PL]; emphasis added).

[64]'However, properly speaking, matter isn't composed of constitutive unities, but results from them ... Substantial unities aren't really parts, but the foundations of phenomena' (G, II 268 [AG 179]).

not actually think there is a genuinely extended plenum, and so it is not clear his comments about the structure of matter should be taken as literally true.[65] In a 1704 letter to de Volder, for example, Leibniz is careful to qualify his claim that 'in bodies, the parts are not indefinite ... but are actually assigned in a certain way', with the statement that 'properly speaking matter, that is, extended mass is only a phenomenon grounded in things, like a rainbow or a parhelion' (G, II 268 [AG 178–9]). Later, in the same letter, Leibniz says that 'matter and motion are not substances or things as much as they are the phenomena of perceivers, the reality of which is situated in the harmony of the perceivers with themselves (at different times) and with other perceivers' (G, II 270 [AG 181]). This suggests that although we can treat genuinely extended matter as something real, as we do when we are doing science, and although the perception of extended matter will always reveal more and more qualitative detail the more distinct our perceptions become, we need to be careful to keep in mind that our theorizing about matter is not theorizing about the way the world is in itself.[66]

V. CONCLUDING REMARKS

Given how little Leibniz says about what justifies the move from infinite division to lack of determinate shape, any interpretation of the argument will necessarily be somewhat speculative. Furthermore, the adequacy of any interpretation of the shape argument will depend on larger issues about Leibniz's ontology in the 1680s. Nevertheless, I think there are good reasons for thinking that Leibniz does intend the argument to be taken as I have suggested. First, my interpretation is closely in keeping with the fact that the arguments against the modes of extension are intended, at least in part, as critiques of Cartesian metaphysics. If Leibniz is arguing, as I claim, that there are no metaphysically determinate shapes or surfaces in an infinitely divided plenum, his criticism cuts deep into the heart of Descartes's conception of matter, for Descartes thinks that size, shape and motion are the only genuine properties of corporeal things, and since shape is dependent on motion and motion is dependent on the existence of determinate bodies, showing that determinate surfaces literally do not exist

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[65]This, I think, is the standard reading. For examples of idealist interpretations of Leibniz's mature philosophy, see Adams, op. cit. and Donald Rutherford, *Leibniz and the Rational Order of Nature* (Cambridge: Cambridge University Press, 1995). For an opposing view, see Loptson and Arthur, op. cit.

[66]I provide a more detailed account of the distinction between discreteness and continuity in 'Continuity in Leibniz's Mature Metaphysics', *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, 119–38.

would be devastating to the idea that the other modes of extension could be real.[67] Second, the interpretation seems plausible in light of Leibniz's desire to use the arguments concerning the modes of extension to establish an immaterial principle as the metaphysical ground of corporeal phenomena; for if shape is of the essence of body, as Leibniz thinks Descartes believes, and shape literally does not exist, then if there is any reality behind our appearances of body, the grounds of that reality must be immaterial. Third, unlike previous anti-realist interpretations, my interpretation does not depend on seeing Leibniz as less sophisticated about mathematics than he actually was. For it does not depend on seeing Leibniz as thinking there is something absurd or impossible about an infinitely complex structure. Fourth, unlike previous interpretations, my reading incorporates his thoughts about the structure of a material plenum that are contemporary with his presentations of the shape argument. As we have seen, in this period Leibniz is especially focused on the implications of fluidity for the cohesion and unity of body; and this suggests that he is aware of the problems that fluidity raises for the individuation of surfaces and bodies in a plenum. If this is correct, then it would be surprising if these considerations played no role in his critique of Cartesian metaphysics and his movement in the direction of a monadological, idealist metaphysics.

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[67]This was probably the thought behind Leibniz's claim that 'there are no precise shapes in the nature of things, and consequently, no precise motions' (A, VI, iv, 279 [RA 263]). I find it hard to make sense of this argument on a realist interpretation because realists believe that bodies have surfaces.

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