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PARTHOOD AND IDENTITY ACROSS TIME*

Temporal parts have come in handy in a number of areas in philosophy.[1] Let us take a close look at one use to which some may be inclined to want to put them.

I

Suppose I own some Tinkertoys. I make a house out of them, finishing the task at 1:00. I put the house, which I shall call "*H*," on an otherwise empty shelf. Since *H* is the only Tinkertoy house now on the shelf, and since also the time now is 1:15, we may truly say

(1) H = the Tinkertoy house on the shelf at 1:15

A tinkertoy house is made of Tinkertoys. And surely a Tinkertoy house is made only of Tinkertoys: surely it has no additional ingredients, over and above the Tinkertoys it is made of. (Perhaps there is such an entity as "house-shape." Even if there is, it certainly is not literally part of any Tinkertoy house.)

It is an attractive idea that the logic of parthood is the Leonard-Goodman Calculus of Individuals,[2] which takes "*x* D *y*" (read: *x* is

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[1] It is familiar enough that they have been used by those interested in the metaphysics of matter. But so also have they been used by those interested in philosophy of mind [cf., for example, David Lewis, "Survival and Identity," reprinted in A. O. Rorty, ed., *The Identities of Persons* (Berkeley: Univ. of California Press, 1976)], and even by moral philosophers [cf., for example, Alan Gibbard, "Natural Property Rights," *Noûs*, x, 1 (March 1976): 77–88, and the views of Jonathan Edwards on moral responsibility, described by Roderick Chisholm in Appendix A of his *Person and Object* (London: Allen & Unwin, 1976)].

[2] Henry S. Leonard and Nelson Goodman, "The Calculus of Individuals and Its Uses," *Journal of Symbolic Logic*, v, 2 (June 1940). For perspicuousness in the discussion to come, I have strengthened their identity axiom.

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discrete from y) as primitive, defines '$x < y$' (read: x is part of y) and 'x O y' (read: x overlaps y) as follows:

$$x < y =_{df} (z)(z \text{ D } y \supset z \text{ D } x)$$
$$x \text{ O } y =_{df} (\exists z)(z < x \ \& \ z < y)$$

and contains the following distinctive axioms:

(CI_1)	$(x = y) \equiv (x < y \ \& \ y < x)$	identity axiom
(CI_2)	$(x \text{ O } y) \equiv -(x \text{ D } y)$	overlap axiom
(CI_3)	$(\exists x)(x \in S) \supset (\exists y)(y \text{ Fu } S)$	fusion axiom

where 'x Fu S' (read: x fuses S, or the Ss, or the members of S) is defined as follows:

$$x \text{ Fu } S =_{df} (y)[y \text{ D } x \equiv (z)(z \in S \supset y \text{ D } z)]$$

(Another way in which we might have defined 'x fu S' is this: x fuses S just in case a thing y is part of x if and only if every part of y overlaps a member of S.)

It is worth stressing that the fusion axiom says only that, if anything is a member of S, then there is a thing that fuses the Ss. What I shall call *the fusion principle*[3] says that if anything is a member of S, then there is a unique thing that fuses the Ss:

$$(\exists x)(x \in S) \supset (\text{E!}y)(y \text{ Fu } S) \qquad \text{fusion principle}$$

Or, as we may put it: if anything is a member of S, then there is such a thing as *the fusion of* the Ss. The fusion principle is provable in the Calculus of Individuals.

I said it is an attractive idea that the logic of parthood is the Leonard-Goodman Calculus of Individuals. If the axioms are true under their intended interpretation, then so is the fusion principle. There are Tinkertoys on the shelf at 1:15; so the fusion principle tells us that there is such a thing as the fusion of the Tinkertoys on the shelf at 1:15. I shall call it "W"; so we can say

(2) W = the fusion of the Tinkertoys on the shelf at 1:15

Surely a Tinkertoy house is made only of Tinkertoys. The Tinkertoys H is made of are the Tinkertoys on the shelf at 1:15. So it very naturally suggests itself that we should say

(3) $H = W$

So far so good; no problem yet.

[3] Following Richard Cartwright, in "Scattered Objects," in Keith Lehrer, ed., *Analysis and Metaphysics* (Dordrecht, Holland; Boston, Mass.: Reidel, 1975).

II

But we should take note of the fact that that fusion axiom makes some people feel nervous. Few, I think, feel nervous about the definitions or about the identity and overlap axioms, but many object to the idea that there is something that fuses (as it might be) the set whose members are all giraffes and all apples. They think the fusion axiom grossly overstrong.

But why? The fusion axiom does commit us to the existence of some pretty odd things, but, so far as I can see, their oddity is no objection to them.

Never mind: the problem I want to set before you arises even if we reject the fusion axiom.

For suppose you have some bits of wood in your hand now; doesn't it follow that there is such a thing as *the wood* in your hand now?

There are some Tinkertoys on the shelf at 1:15, and, since Tinkertoys are bits of wood, it seems right to say there therefore is such a thing as the wood on the shelf at 1:15. Let us call it "*W′*"; so we can say

(2′) W' = the wood on the shelf at 1:15

Surely a Tinkertoy house is made only of Tinkertoys. The Tinkertoys *H* is made of are the Tinkertoys on the shelf at 1:15. The Tinkertoys on the shelf at 1:15 are themselves bits of wood. So it very naturally suggests itself that we should say

(3′) $H = W'$

If the fusion principle is true, then there is such a thing as the fusion of the Tinkertoys on the shelf at 1:15. I gave that thing the name '*W*'. If there is such a thing as *W*, it seems plausible to suppose that *W′* is identical with it; i.e., it seems plausible to suppose that the wood on the shelf at 1:15 *is* the fusion of the Tinkertoys on the shelf at 1:15.

Even if the fusion principle is not true—in that the fusion axiom is overstrong—it seems plausible to suppose that there is such a thing as *W* and that *W′* is identical with it; i.e., even if the fusion principle is not (in general) true, it seems plausible to suppose that there is such a thing as the fusion of the Tinkertoys on the shelf at 1:15 and that the wood on the shelf at 1:15 is identical with it.

But whether or not there is such a thing as *W*, it really does seem plausible to suppose that there is such a thing as *W′*, the wood on the shelf at 1:15. *And* that the Tinkertoy house *H* is identical with

it. That will suffice for generating the problem I want to set before you.

III

For let us give the name 'alpha' to one of the sticks that help attach the roof of the house to its front wall. At 1:30, I remove alpha; I then replace alpha with a new stick, beta, and I throw alpha on the floor. Shortly thereafter, the time is 1:45. Is *H* still on the shelf at 1:45? That is, can we truly say

(4) *H* is on the shelf at 1:45 ?

Most of us are, I think, inclined to think we can: most of us are inclined to think that *H* survives replacement of alpha by beta and is still on the shelf at 1:45.

Now there is trouble. For the conjunction of (3′) and (4) entails

(5′) *W′* is on the shelf at 1:45

which is not true, for *W′* is only partly on the shelf at 1:45—the wood on the shelf at 1:15 is partly on the floor at 1:45, since alpha is on the floor at 1:45.

So also of course the conjunction of (3) and (4) entails

(5) *W* is on the shelf at 1:45

which is also not true, even if there is such a thing as *W*. For *W* is only partly on the shelf at 1:45—the fusion of the Tinkertoys on the shelf at 1:15 is partly on the floor at 1:45, since alpha is on the floor at 1:45.

What to do? Something has to give.

Well, we really must retain (4). Surely that *is H* on the shelf at 1:45. (This *is* the typewriter I bought five years ago, though I've had a key replaced.)

So it is the identity sentences (3) and (3′) which have to go. But it seemed intuitively right to say that a Tinkertoy house is made only of Tinkertoys. It was that intuition which led us to identify *H* first with *W* and then, anyway, with *W′*. There has got to be something right in that intuition; but what is the something right in it, if (3) and (3′) are not true? How *is H* related to *W′*—and to *W*, if there is such a thing as *W*?

David Wiggins,[4] I think, would say that *W*, or anyway *W′*, *constitutes H* at 1:15, and that that is the most that can be retained of the intuition that a Tinkertoy house is made only of Tinkertoys.

[4] *Sameness and Substance* (Cambridge, Mass.: Harvard, 1980), p. 30ff.

He may be right. But we cannot tell until we are made clearer than Wiggins makes us about just what it is for a thing x to constitute a thing y at a time t.

Richard Cartwright (*op. cit.*) draws attention to a solution that appeals to temporal parts. By hypothesis, H came into existence at 1:00, and alpha was removed from H at 1:30. H was in existence throughout that time; and suppose we allow ourselves to say that H therefore had a temporal part that came into existence at 1:00 and went out of existence at 1:30. If you like the fusion principle, you will think there is such a thing as W. It too was in existence throughout that time; and suppose we allow ourselves to conclude that it too had a temporal part that came into existence at 1:00 and went out of existence at 1:30. Let us call these entities, respectively, "H-from-1:00-to-1:30" and "W-from-1:00-to-1:30". Friends of temporal parts take it that the temporal parts of a thing are, literally, parts of it; so we should say

$$H\text{-from-1:00-to-1:30 is part of } H$$

and

$$W\text{-from-1:00-to-1:30 is part of } W$$

A Tinkertoy house is made only of Tinkertoys. Throughout 1:00 to 1:30, H was made of the Tinkertoys that W fuses; so shouldn't we say

$$H\text{-from-1:00-to-1:30} = W\text{-from-1:00-to-1:30}$$

and thus that H and W share a part—that they literally overlap? Tinkertoy houses may be made of different Tinkertoys at different times, however; so don't we preserve as much as anyone could want of the spirit of "A Tinkertoy house is made only of Tinkertoys" if we say, quite generally, that, for every temporal part x of a Tinkertoy house, there is a Tinkertoy fusion y such that x is identical with, or at least overlaps, some temporal part of y?

Of course you may not think there is any such thing as W. Then you are cordially invited to rewrite the preceding paragraph, replacing 'W' by 'W'', and making the necessary changes elsewhere in it.

But what exactly *are* these putative entities H-from-1:00-to-1:30 and W-from-1:00-to-1:30? Friends of "temporal parts" do seem to be just a bit casual about the manner in which they explain their use of that term; and a number of people have, rightly, complained that we are owed something more careful in the way of an account of them than we are commonly given.

IV

There are a number of different ways of defining the expression 'temporal part'. I shall try to define it in such a way as to lend the greatest possible plausibility to the metaphysical theses commonly asserted by use of it.

What we are interested in here is physical objects and their parts. Could I have said, more briefly, that what we are interested in here is physical objects? That is, is *not* every part of a physical object itself a physical object? I should think so. But let us not assume this. (I shall come back to it below.) Let us take the variables '*x*', '*y*', etc. to range over physical objects and their parts. Then the first of the metaphysical theses that must be accommodated is this:

(M_1) If x is a temporal part of y, then x is part of y.

As I said, friends of temporal parts take it that the temporal parts of a thing are *literally* part of it.

Or at least I think they do. For all I know there may be those who think that the temporal parts of a thing are not parts of it, but only parts of something else, perhaps of the thing's history. I shall ignore that idea. (In any case, it is not clear exactly how appeal to temporal parts is to help anyone see how *H* is related to *W* and *W'* if their temporal parts are not among their parts.)

I should think that M_1 rules out taking the temporal parts of a physical object to be sets. Thus the temporal parts of my chair, for example, cannot be identified (as it might be) with the sets whose members are the chair and a time-point or time-stretch at or through which the chair exists, for I should think that no set is literally part of my chair.

What I suggest we do is attend to places as well as times. We have the idea that no two things can occupy the same place at the same time. Well, I hope that on reflection we shall conclude that that idea is false. But if two things occupy the same place at the same time, then don't they at least overlap? Don't they literally share a part? That at any rate is the root idea that generates the definitions I shall give.

It will be simplest if we can make a certain assumption, viz., that every physical object, and every part of every physical object, exactly occupies exactly one place at every time-point at which it exists. I mean to include among "places," of course, discontinuous places, since there are physical objects that occupy such places now—for example, my suit now occupies a discontinuous place, the jacket being on one hanger and the skirt on another.

On one way of construing 'places', that is a strong, and presumably false, assumption. Suppose we take places to have "sharp boundaries." (Because they are sets of space-points? Because they are fusions of sets of space-points? No matter.) Common or garden physical objects presumably do not have sharp spatial boundaries. (What *exactly* are the spatial boundaries of my chair now?) But let us simply ignore the questions raised here. Let us take places to have sharp boundaries, and ignore the fact that making the assumption therefore involves spatial idealizing.

We are letting *'x'*, *'y'*, etc. range over physical objects and their parts. Let *'P'* range over places. Let *t* range over time-points, and *'T'* over times. I include time-stretches among the times. I also include time-points among the times, since many (most? all?) friends of temporal parts take it that physical objects have temporal parts that exist only at a time-point—i.e., that physical objects have temporal "slices" as well as temporal "chunks." (So the range of *'t'* is included in the range of *'T'*.)

We go in two steps. Let us say, first,

x is a cross-sectional temporal part of $y =_{df}$
$(\exists T)[y$ and x exist through T & no part of x exists outside T & $(t)(t$ is in $T \supset (P)(y$ exactly occupies P at $t \supset x$ exactly occupies P at $t))]$.

Consider again the Tinkertoy house *H*. It existed through the time-stretch 1:00 to 1:30. If there is an *x* such that *x* exists through that time-stretch and such that no part of *x* exists outside that time-stretch and such that, for all time-points in that time-stretch, if *H* exactly occupies a place, then *x* exactly occupies it too—*if* there is such an *x*, then this definition tells us that *x* is a cross-sectional temporal part of *H*. The definition does not tell us that there is such an *x*. The friends of temporal parts, of course, think there is; but telling us there is is the job, not of any definition, but of a second metaphysical thesis, viz.,

(M_2) $(T)[y$ exists through $T \supset (\exists x)(x$ exists through T
& no part of x exists outside T & $(t)(t$ is in $T \supset$
$(P)(y$ exactly occupies P at $t \supset x$ exactly occupies P at $t))]$.

Consider again alpha, the stick that was in *H* until I removed it at 1:30. M_2 tells us that alpha had a cross-sectional temporal part that existed only from 1:00 to 1:30. Shouldn't all cross-sectional temporal parts of alpha which existed only during that time be

temporal parts not merely of alpha, but also of H itself? Presumably they should; so let us say

x is a temporal part of $y =_{df}$
$(\exists T)[y$ and x exist through T & no part of x exists outside T
& $(t)(t$ is in $T \supset (P)(y$ exactly occupies P at t
$\supset x$ exactly occupies P, or a place in P, at $t))]$.

This definition tells us that cross-sectional temporal parts of alpha which exist only during 1:00 to 1:30 are temporal parts of alpha—and of H.

Nothing so far said ensures uniqueness. For example, nothing so far said ensures that, if H exists through 1:00 to 1:30, then there is *exactly one* x such that x exists through that time-stretch and such that no part of x exists outside that time-stretch and such that, for all time-points in that time-stretch, if H exactly occupies a place, then x exactly occupies it too. But shouldn't uniqueness be ensured? I think that friends of temporal parts would like it ensured; indeed, I think they accept a third metaphysical thesis, viz.,

(M_3) If x is part of y and y is part of x, then x is identical with y.[5]

Between them, M_1 and M_3 ensure the desired uniqueness. For suppose, for example, that x and x' both have that rather complicated relation to H which I just drew attention to. Then x and x' have it to each other. Then x and x' are cross-sectional temporal parts of each other and, hence, temporal parts of each other and, hence, by M_1, parts of each other. It follows, by M_3, that x is identical with x'.

M_3 is obviously a consequence of the identity axiom

$$(x = y) \equiv (x < y) \,\&\, (y < x)$$

of the Calculus of Individuals under its intended interpretation. Friends of temporal parts need not assent to all the axioms of that Calculus: for all I know, some of them reject the fusion axiom as too strong. (So far as I can see, there is nothing in the metaphysic of temporal parts which commits its adherents to the existence of a thing that fuses the set whose members are all giraffes and all apples.) But I think they are all of them happy to assent to the identity axiom.

M_2 tells us that there is an x that is a cross-sectional temporal part of alpha lasting only from 1:00 to 1:05 and that there is a y that is a cross-sectional temporal part of H lasting only from 1:10

[5] But see section VII, fn. 12 in particular.

to 1:15; and the definition of 'temporal part' tells us that both x and y are temporal parts of H. Does it follow that there is an entity that fuses x and y? I think that even those friends of temporal parts who think that the fusion axiom is not (in general) true would assent to

> If x is a temporal part of z and y is a temporal part of z, then there is a z' that fuses the set whose members are x and y

If this is true, then (in light of what precedes) they can say that there is exactly one such z' and that it is, itself, a temporal part of z. But I do not give this further metaphysical thesis a name, since I suppose it is just barely possible that some friend of temporal parts thinks that even *this* "fusion thesis" is too strong.

I have obviously been so using the expression 'is part of' to stand for a reflexive relation: I have been throughout using it in such a way as to make it true to say that everything is part of itself. I think all friends of temporal parts use the expression 'is a temporal part of' in that way too—i.e., in such a way as to make their fourth and final metaphysical thesis

(M_4) x is a temporal part of x

true.

That looks at first glance like an uninteresting metaphysical thesis; so it pays us to take note of the fact that it is very strong indeed.

In the first place, with M_4 in hand we can now easily deduce that every physical object, and every part of every physical object, is the fusion of its temporal parts. But after all, that consequence is presumably just as it should be—the friends of temporal parts would welcome it.

In the second place, we should ask: do "times" have "sharp boundaries"? If so, something that is presumably false now follows. Consider a common or garden physical object—my chair, for example. M_4 tells us it is a temporal part of itself. The definition of 'temporal part' tells us that this means there is a time T such that my chair exists through T and such that no part of my chair exists outside T and so, in particular, such that my chair itself does not exist outside T. But is there? Is there a time-point t such that my chair was in existence at t and at no time before t? Or a time-point t such that my chair was not in existence at or before t, but was in existence at times as close after t as you like? I should think not: I should think there is no such thing as the *exact* temporal boundary of a chair.

Well, temporal idealizing is presumably no worse than spatial idealizing, and those who are still reading are already engaging in the latter activity—see p. 207 above.

The third consequence is far more serious. M_4 tells us that my chair is a temporal part of itself, and this means there is a time T such that my chair exists through T and such that no part of my chair exists outside T and so, in particular, such that my chair exists through and only through T and no part of it exists before T. Now my chair was made out of wood: four wooden legs, a wooden seat, and a wooden back were screwed together to make that chair. So the legs, seat, and back existed before the chair existed; so neither the legs, seat, nor back of the chair are parts of the chair. What an absurd result to have arrived at!

"No doubt it sounds odd," says the friend of temporal parts with a sigh. "But it can be lived with. For keep this in mind: if the legs, seat, and back of the chair are not themselves parts of the chair, they do at all events overlap the chair—since they have temporal parts that are temporal parts of the chair."

And perhaps the friend of temporal parts doesn't even sigh. A Tinkertoy house is made only of Tinkertoys; and isn't a chair made only of bits of wood, metal, cloth, etc.? And how is this intuition to be more tidily accommodated than by saying that every temporal part of a chair overlaps a temporal part of one or other of the bits of wood, metal, cloth, etc., of which it is made—and that the chair itself just is the fusion of its temporal parts?

More precisely: by saying that every temporal part of a chair overlaps a temporal part of one or other of the bits of wood, etc., of which the chair is at some time or other made. A Tinkertoy house is made only of Tinkertoys, but it may be made of different Tinkertoys at different times—remember the replacement of beta for alpha in H. Similarly, a chair may be made of different bits of wood, etc., at different times. How better to capture what goes on when a chair or house is made or when a bit of stuff is replaced in a chair or house, than by adoption of the metaphysic of temporal parts?

V

It seems to me a crazy metaphysic—obviously false. But it seems to me also that there is no such thing as a *proof* that it is false.[6]

Some people have the idea that it follows from this metaphysic that the world is static, that nothing changes, and that, that being false, the metaphysic must be false. But why should we think that this does follow? A thing changes if and only if it has a feature at

[6] But see section VII, fn. 12 in particular.

an earlier time which it lacks at a later time. And a friend of temporal parts says that changes take place all the time, but that a thing does have a feature at an earlier time which it lacks at a later time if and only if earlier cross-sectional temporal parts of the thing have it and later cross-sectional temporal parts of the thing lack it.

Again, some people object to the fact that this metaphysic yields that more than one thing can occupy a given place at a given time—e.g., the cross-sectional temporal part of *H* which exists only from 1:00 to 1:30 occupies the very same place at 1:15 as *H* itself occupies at 1:15. But should we take this seriously? On reflection, it does not appear to be a conclusive objection. For after all, the metaphysic also yields that those two things, though not identical, are not discrete—it yields that the former is part of the latter.

I have deliberately refrained from including among the metaphysical theses anything that says that the temporal parts of a thing are ontologically or epistemologically "prior" to it. These are dark notions; but I think we have *some* grip on what they are, enough perhaps to be able to construct a (more or less messy) argument to the effect that the temporal parts of a physical object are not ontologically or epistemologically prior to it. No matter. What concerns me now is not their priority, but their very existence.

Why should we accept this metaphysic? I am inclined to think that the friends of temporal parts are largely motivated by two things: one, the fact that so many problems in philosophy having to do with identity across time can be so tidily solved by appeal to them, and, two, what might be called "the spatial analogy." I shall come back to the first later; let us attend now to the second.

Suppose I have a piece of chalk in my hands now, one end in my right hand, the other in my left. It is a plausible idea that there is such a thing as the "right-hand half" of the bit of chalk. (No part of it is in my left hand.) If there is such a thing, we might as well call it "Alfred."

Friends of temporal parts say that, analogously, there is such a thing as the "later half" of the bit of chalk. (No part of it existed when the chalk first came into existence.) If there is such a thing, we might as well call it "Bert."

I think it is not merely plausible to think that there is such a thing as Alfred, but that we are under considerable pressure to say that there is. For I can break the bit of chalk in half. (Actually, it isn't easy to break a bit of chalk *exactly* in half, but I might be lucky.) If I do, I will have something in my right hand which is white, roughly cylindrical in shape, dusty, etc.; and it could hardly

be said that that thing will come into existence at breaking-time—surely the thing does exist before I break it (note that "it") off. And surely the thing does exist now, even if I never break it off.

There is no analogous pressure to say that there is such a thing as Bert, (Homework: try breaking a bit of chalk into its two temporal halves.)

Friends of temporal parts are quite unmoved by this difference. They say: No doubt there are differences, but why shouldn't we take lasting through time to be analogous with extending through space? Why shouldn't we say that, just as there is Alfred, so also there is Bert?

Let us look at the consequences for Bert of the idea that Bert is to be Alfred's temporal analogue.

Is Alfred a physical object? It would presumably be wrong to say that Alfred is a bit or piece or chunk of chalk. If I break Alfred off, Alfred will become a bit of chalk; but I have not in fact broken Alfred off. It is an interesting and not easily answerable question why Alfred is not now a bit of chalk. The point isn't that Alfred isn't independently movable, for you can glue two bits of wood together, which are then two bits of wood that are not independently movable. (Of course you could break off one of the bits of wood; but so could you break Alfred off.) And I think the point isn't that Alfred is continuous with more chalk; for if Alfred had been broken off and were now being held carefully in place again, it is arguable that Alfred would have been a bit of chalk continuous with another bit of chalk. No matter: as things stand, Alfred is not a bit or piece or chunk of chalk.

Something similar should presumably be said of Bert, viz., that it too is not a bit or piece or chunk of chalk. (For temporal parts come and go during a time in which I have only one bit of chalk in my hand.)

Now perhaps it may be thought that a thing is not a physical object unless it is a bit or piece or chunk of stuff of some kind. It would be no surprise if one who took this view thought that neither Alfred nor Bert is a physical object. It was to allow for the possibility that someone might take this view that I said we should take *'x'*, *'y'*, etc. to range not merely over physical objects, but also over anything that is part of a physical object.

What are Alfred and Bert then? Well, perhaps it will be said that they are quantities[7] of chalk. Or portions[8] of chalk. Which leaves it

[7] In the sense singled out by Helen Morris Cartwright, in "Quantities," *The Philosophical Review*, LXXIX, 1 (January 1970): 25–42.

[8] Following Allan Gibbard, in "Contingent Identity," *Journal of Philosophical Logic*, IV, 2 (May 1975): 187–221.

open for them to be perfectly respectable entities, with any number of ordinary physical properties. Thus Alfred presumably is white, roughly cylindrical in shape, and dusty; if the bit of chalk now weighs three ounces, then Alfred presumably now weighs an ounce and a half; and so on. And shouldn't we say, analogously, that Bert is white, roughly cylindrical in shape, and dusty? Perhaps by the time Bert comes into existence, the bit of chalk will weigh less than three ounces; but surely Bert will have some weight or other at every time at which it exists—just as Alfred does. If Alfred and Bert are not bits of chalk, and therefore not physical objects, they are anyway, both of them, surely *chalk*.

If Bert has not got these properties, then it is very obscure what Bert is, and hard to see why drawing our attention to Alfred should incline us to think there is such a thing as Bert.

I said this seems to me a crazy metaphysic. It seems to me that its full craziness comes out only when we take the spatial analogy seriously. The metaphysic yields that if I have had exactly one bit of chalk in my hand for the last hour, then there is something in my hand which is white, roughly cylindrical in shape, and dusty, something which also has a weight, something which is chalk, which was not in my hand three minutes ago, and indeed, such that no part of it was in my hand three minutes ago. As I hold the bit of chalk in my hand, new stuff, new chalk keeps constantly coming into existence *ex nihilo*. That strikes me as obviously false.

At a minimum, we ought to see whether there isn't some less extravagant way of solving the problem with which we began.

VI

What exactly is the problem? Whether or not there is such a thing as W (the fusion of the Tinkertoys on the shelf at 1:15), there is such a thing as W' (the wood on the shelf at 1:15). A Tinkertoy house is made only of Tinkertoys; that is an intuition we should like to preserve. Tinkertoys are bits of wood. So it seems right to say that the Tinkertoy house H is identical with W'. But at 1:30, I remove alpha from H, and then replace it with beta. H is on the shelf at 1:45, but W' is not then on the shelf, for alpha is on the floor at 1:45. So how *is* H related to W'?

I spoke earlier of alpha's having been "in H" until 1:30, when I removed it from H and replaced it with beta. I have been trying throughout (not without difficulty) to avoid speaking as common sense speaks. Common sense says: alpha was part of H, and then ceased to be; beta was not part of H, but became part of H.

It really is the most obvious common sense that a physical object can acquire and lose parts. Parthood surely is a three-place relation, among a pair of objects and a time. If you want to construe

parthood as a two-place relation, you really will have to indulge in temporal parts to accommodate what common sense calls acquisition and loss of parts. But why should anyone want to?

If parthood is a three-place relation, then it is not possible to read the expression '$x < y$' of the Calculus of Individuals as: x is part of y. And it cannot be said that the logic of parthood is the Calculus of Individuals.

But we can easily construct a Cross-temporal Calculus of Individuals, by emending the Leonard-Goodman definitions and axioms. I think it pays us to do so.

Let us take as primitive 'x D y @ t', and read it as: x is discrete from y at t.[9]

But we cannot move on just yet. For the intended interpretation of 'x D y @ t' to be fixed, it has to be fixed for all threesomes of a pair of objects and a time-point which make 'x D y @ t' true and which make it false. There is no difficulty if both objects exist at the time-point: your nose is now discrete from my nose, your nose is not now discrete from your face, and so on. But what if one or more of the objects does not exist at the time-point? Is Caesar's nose now discrete from your nose?

Looking ahead, we know that the intended interpretation of 'x D y @ t' is to be such as to link it with parthood-at-a-time. For example, the threesome containing A, B, and 9 P.M. should make 'x D y @ t' true if and only if A and B have no part in common at 9 P.M. More precisely: if and only if there is no z such that z is part of A at 9 P.M. and z is part of B at 9 P.M. Well, is there a z such that z is *now* part of Caesar's nose? After all, Caesar's nose does not exist now. I think it will seem right to say: if x does not exist at t, then there is no z such that z is part of x at t. (If my car goes out of existence at midnight tonight, nothing will be part of it tomorrow.) If we do adopt this view, we are committed to saying that there is no z that is now part of Caesar's nose and, therefore, no z that is now part of both Caesar's nose and your nose and, thus, that Caesar's nose is now discrete from your nose. More generally, adopting this view is adopting an existence principle expressible as follows:

x does not exist at $t \supset (y)(x \text{ D } y \text{ @ } t)$ first existence principle

I think it really does seem right to say these things—until it strikes us that it follows that not even Caesar's nose is now part of Caesar's

[9] The variables of the Calculus of Individuals range only over existing entities. In the same spirit, the variables 'x', 'y', etc. of the Cross-temporal Calculus of Individuals are to range only over entities that exist at some time or other.

nose and that Caesar's nose is now discrete even from itself. There is no entirely happy alternative in the offing here. We might weaken the first existence principle; e.g., we might choose to say, instead,

$$x \text{ does not exist at } t \supset (y)(x \text{ D } y \text{ @ } t \equiv y \neq x)$$

But this has its own unhappy consequence, viz., that a thing is atomic at all times at which it does not exist; and choosing it would impose complications elsewhere. So I suggest we accept the unhappy consequences of what I called the "first existence principle," and take it to control the intended interpretation of 'x D y @ t'.

We should surely say also that, if everything is now discrete from a thing, then that thing does not now exist—more generally, that

$(y)(x \text{ D } y \text{ @ } t) \supset x \text{ does not exist at } t$ second existence principle

The conjunction of the first and second existence principles is

$$x \text{ does not exist at } t \equiv (y)(x \text{ D } y \text{ @ } t)$$

or, alternatively,

$$x \text{ exists at } t \equiv \sim(y)(x \text{ D } y \text{ @ } t)$$

So we may introduce 'x E@ t' (read: x exists at t) by definition as follows:

$$x \text{ E@ } t =_{df} \sim(y)(x \text{ D } y \text{ @ } t)$$

'$x < y$ @ t' (read: x is part of y at t) and 'x O y @ t' (read: x overlaps y at t) are now definable as follows:

$$x < y \text{ @ } t =_{df} x \text{ E@ } t \text{ \& } y \text{ E@ } t \text{ \& } (z)(z \text{ D } y \text{ @ } t \supset z \text{ D } x \text{ @ } t)$$
$$x \text{ O } y \text{ @ } t =_{df} (\exists z)(z < x \text{ @ } t \text{ \& } z < y \text{ @ } t)$$

The old overlap axiom is easy enough to emend: what we want is

(CCI_2) $(x \text{ O } y \text{ @ } t) \equiv \sim(x \text{ D } y \text{ @ } t)$ new overlap axiom

The old identity axiom is not so easily emended, however. That is, we obviously cannot replace it with

$$(x = y) \equiv (x < y \text{ @ } t \text{ \& } y < x \text{ @ } t)$$

for this tells us that, whatever time you choose, x is identical with y only if x is part of y at that time and y is part of x at that time and, thus (by the definition of '$x < y$ @ t'), only if x and y exist at that time. That is far too restrictive. Caesar's nose is surely identical with Caesar's nose, even if it does not exist now.

What we want is instead this: x is identical with y if and only if for all times t such that one or the other of them exists at t, x is part of y at t, and y is part of x at t—i.e.,

$$(\mathrm{CCI}_1) \quad (x = y) \equiv (t)[(x \text{ E@ } t \vee y \text{ E@ } t) \supset (x < y \text{ @ } t \,\&\, y < x \text{ @ } t)]$$

new identity axiom

A great many analogues of theorems of the Calculus of Individuals are now provable in the Cross-temporal Calculus of Individuals. It is perhaps just worth drawing attention to the fact that, although '$x < x$' is provable in the Calculus of Individuals, '$x < x$ @ t' is not provable in the Cross-temporal Calculus of Individuals. But it plainly ought not be; for what it tells us is that, whatever time you choose, x is part of itself at that time and thus (by the definition of '$x < y$ @ t') that everything exists all the time. What is provable in the Cross-temporal Calculus of Individuals is, instead, this:

$$x \text{ E@ } t \equiv x < x \text{ @ } t$$

which says only that, whatever time you choose, x is part of itself at that time if and only if it exists at that time.

The old fusion axiom presents a different kind of problem. If things can have different parts at different times, then a thing can fuse one set at one time and a different set at a different time. Indeed, fusing has to be regarded as relativized to times, and I suggest we redefine it as follows:

$$x \text{ Fu } S \text{ @ } t =_{\mathrm{df}}$$
$$x \text{ E@ } t \,\&\, (y)[y \text{ D } x \text{ @ } t \equiv (z)[(z \in S \,\&\, z \text{ E@ } t) \supset t \text{ D } z \text{ @ } t]]$$

One possible analogue of the old fusion axiom is, then, this:

$$(\mathrm{CCI}_3) \quad (\exists x)(x \in S \,\&\, x \text{ E@ } t) \supset (\exists y)(y \text{ Fu } S \text{ @ } t)$$

But that is only one of the possibilities. It is, after all, rather weak. It allows us to say, for example, that there is something that fuses Caesar's nose in 44 B.C. and that there is something that fuses Nixon's nose in 1979; but it does not allow us to conclude that there is something that both fuses Caesar's nose in 44 B.C. and fuses Nixon's nose in 1979. Admirers of the Calculus of Individuals will surely want that there be such a thing and will, therefore, regard the axiom I set out as too weak to be regarded as the appropriate analogue of the old fusion axiom.

There are a number of available middle grounds, but I suspect that the truly devoted friends of fusions will want to go the whole distance. The simplest way of expressing their view is to take them

to say that there is not one fusion axiom in the Cross-temporal Calculus of Individuals, but indefinitely many, the procedure for generating them being this. Take any set of n sets $S_1 \ldots S_n$. For $n = 1$, write what I earlier called (CCI_3). For $n = 2$, write

$$[t_1 \neq t_2 \,\&\, (\exists x)(x \in S_1 \,\&\, x \text{ E@ } t_1) \,\&\, (\exists y)(y \in S_2 \,\&\, y \text{ E@ } t_2)] \supset (\exists z)(z \text{ Fu } S_1 \text{ @ } t_1 \,\&\, z \text{ Fu } S_2 \text{ @ } t_2)$$

and so on. For my own part, I have no objection—it seems to me that one has only to live with fusions for a while to come to love them. But I shall not argue for all or even any of these fusion axioms. I do not know what an argument for them would look like. By the same token, however, I do not know what an argument against them would look like, "What an odd entity!" not seeming to me to count as an argument. So I shall leave it open which fusion axiom or axioms should be regarded as replacing the old fusion axiom.

More precisely, I shall leave it open which fusion axiom or axioms should be regarded as replacing the old fusion axiom, so long as the axiom or axioms chosen do not guarantee the uniqueness of fusions. For we do not want an analogue of what I earlier called "the fusion principle" to be provable in the Cross-temporal Calculus of Individuals. The fusion principle, it will be remembered, says that, if anything is a member of S, then there is a unique thing that fuses the Ss. We do not want to have it provable that if anything is a member of S and exists at t, then there is a unique entity that fuses the Ss at t: we want, precisely, to leave open that there may be more than one. My reason for saying that issues from the use to which I would like to be able to put these notions. Consider again the Tinkertoy house H. A Tinkertoy house is made only of Tinkertoys; and H is, at 1:15, made only of the Tinkertoys on the shelf at 1:15. I would like, therefore, to be able to say that H fuses, at 1:15, the Tinkertoys on the shelf at 1:15. And what about W', the wood on the shelf at 1:15? I would like to be able to say that that too fuses the Tinkertoys on the shelf at 1:15. But nothing can be true if it licenses our concluding from this that H is identical with W'.

With fusions now relativized to times, we cannot single out a thing to call "W" as I did in section I above:

(2) W = the fusion of the Tinkertoys on the shelf at 1:15

now lacks a sense, for there now is no fusing *simpliciter*, there is only fusing-at-a-time. And, without an analogue of the fusion principle, we cannot even single out a thing to call "W" by draw-

ing attention to the fact that there is something that fuses, at 1:15, the Tinkertoys on the shelf at 1:15: i.e., we cannot replace (2) with

W = the unique thing that fuses, at 1:15, the Tinkertoys on the shelf at 1:15

for there may be more than one thing that does this. Indeed, I suggest we agree that there are at least two things which do this, viz., H and W′.

Perhaps you have no taste for fusions, and regard the new fusion axioms (like the old one) as grossly overstrong. All the same, the difficulty we began with can be eliminated, and without appeal to temporal parts, if we say that parthood is a three-place relation[10] and that the new identity axiom (interpreted as I indicated) is true. How is H related to W'? We can say, quite simply, that

$$H < W' \text{ @ } t \text{ \& } W' < H \text{ @ } t$$

is true for all times t between 1:00 and 1:30 (which was when alpha was removed from H); but that it is not true for any other times t. Since H and W' exist at times at which it is not true, H is not identical with W'.[11]

More generally, a Tinkertoy house is made only of Tinkertoys, and Tinkertoys are bits of wood; so, at every time throughout its life, a Tinkertoy house is part of, and contains as part, the wood it is made of at that time.

VII

There is a difficulty analogous to the one we began with, which I suggest we look at briefly.

Let us supply the Tinkertoy house H with a different history. Suppose H came into existence on a shelf at 1:00 and that all the Tinkertoys it was then made of, indeed, all the bits of wood, indeed, all of the stuff it was then made of, came into existence at

[10] Unlike physical objects, events really do have temporal parts (though the term must be defined differently for events); hence there is no need to use tenses in ascribing parthood relations to events. We can take events to be a model of the Cross-temporal Calculus of Individuals (reading x E@ t as: x is occurring at t). But the event-identities so obtained would be the same as those I obtained [in *Acts and Other Events* (Ithaca, N.Y.: Cornell)] by taking events to be a model of the simpler Calculus of Individuals.

[11] David Wiggins would say that W' *constitutes* H at 1:15—see p. 204 above. I said: fine, but what is it for a thing x to constitute a thing y at a time t? I have no great confidence in the likelihood of his accepting the gift, but I offer him the following:

$$x \text{ constitutes } y \text{ at } t =_{df} x < y \text{ @ } t \text{ \& } y < x \text{ @ } t$$

On this account of the matter, H constitutes W' at 1:15 if W' constitutes H at 1:15; but that strikes me as harmless.

1:00 along with H. Suppose that the whole thing rested quietly on the shelf until 5:00, and then everything—house, bits of wood, stuff—all went out of existence together. Let W' be, as before, the wood on the shelf at 1:15. Now we can say more than that W' is part of H from 1:00 to 1:30, and H part of W' from 1:00 to 1:30: we can say that, for all times t such that either of them exists at t, W' and H are parts of each other at t. It follows, by the new identity axiom, that H is identical with W'.

Is that an acceptable conclusion? I am sure that there are those who will say it is not. For isn't it true of W', and false of H, that W' could have failed to have the form of a house? Can't wood come into existence in ship shape as well as in house shape? But houses can't.

But is that a possible history? Normally, a house that *is* made of Tinkertoys *was* made of Tinkertoys; i.e., normally, the Tinkertoys existed before the house did, and the house was then built out of them. Could a house, and the Tinkertoys it is made of, come into existence together?

Again, could some wood have come into existence *ex nihilo*? (Compare the temporal parts of the bit of chalk.)

Well, I was being unfair to those who think there is a problem in the offing here. Let us suppose I make a house, not out of Tinkertoys, but out of ice. I do so, not by fitting bits of ice together, but by pouring water into a house-shaped ice-tray, and freezing it. Four hours later, I melt the whole thing down, and throw out the water. Worries about temporal idealizing apart, we can say that the house and the ice it was made of came into existence (and went out of existence) together. And the ice didn't come into existence *ex nihilo*—it came into existence *ex aqua*. But surely (it will be said) the house is not identical with the ice. For the ice, but not the house, could have failed to have the form of a house. I could have poured that very same water into a ship-shaped ice-tray instead.

I don't myself find it obvious that a piece of house-shaped ice could have been a piece of ship-shaped ice; but my informants tell me it could have been. If they are right, we must give up the Cross-temporal Calculus of Individuals, because we must give up the new identity axiom.[12]

[12] If my informants are right, then the friends of temporal parts must give up metaphysical thesis M_3 and, therefore, the old identity axiom and, therefore, the Calculus of Individuals. They can still construe parthood as a two-place relation; but they must take identity to be governed, instead, by

$$(x = y) \equiv \Box[(x < y) \,\&\, (y < x)]$$

Suppose they are right. Then we must take the logic of parthood to be a modal logic, which might be called the Modal Cross-temporal Calculus of Individuals.

I shall not construct such a logic, since I think it does not pay to rehearse the alternative possible replacements for the fusion axiom or axioms. What matters for present purposes, in any case, is really only what should be said about identity. It seems to me, however, that that is plain enough: we should replace CCI_1 with:

$$(MCCI_1)\,(x = y) \equiv \Box(t)[(x\ \mathrm{E@}\ t \vee y\ \mathrm{E@}\ t) \supset (x < y\ @\ t \,\&\, y < x\ @\ t)]$$

That eliminates the difficulty. Let 'House' be the name of the house, and 'Ice' be the name of the ice it is made of. Then (if my informants are right) there is a world, and a time t in that world, such that

$$\text{Ice E@ } t$$

is true, and (since House does not exist in that world)

$$\text{Ice} < \text{House @ } t \,\&\, \text{House} < \text{Ice @ } t$$

is false. That being so, $MCCI_1$ tells us that House is not identical with Ice.

But this is of interest only if my informants are right about this case, or would be right about a better case.

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ON THE IDENTITY OF ARTIFACTS

Philosophical investigations of the conceptual sort are often pursued in the light of puzzle cases; and this is, I think, both understandable and (at least up to a point) justifiable, since it is only by pressing our concepts to their limits that we may discover where their boundaries lie and thus achieve some insight into their logical shape. This is as true in the philosophy of identity as in that of any other concept worthy of philosophical investigation. Hence, in discussions of *personal* identity, the abundance of examples involving amnesia, paramnesia, duplication of memories, brain transplantation, commissurotomy, and so forth. Philosophers concerned with *artifact* identity exhibit the same interest in puzzling or paradoxical cases, and of these the example of the ship

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