CHAPTER 1

Material Objects

I assume that, whatever else may be true of us, you and I are material objects, so clarifying what these are, as I will attempt to do in this chapter, will help us to understand our nature. Even if it turns out that my assumption is false, and we are not material objects, it will be instructive to ask what they are, for we certainly seem to be intimately related to them, whether that relation is identity or not.

It cannot be clear from the outset what I mean to ask when I raise the question: What is a material object? Hence, I will begin the chapter with some preliminary points about what I am looking to do.

After these preliminaries, I will develop an account of what it is for some things to compose a material object at a particular time. Because a material object composed of some things at one time may be composed of different things at other times, I will also need an account of the changing composition of material objects. Having supplied these, I will move on to develop some ideas about what happens when objects come apart or combine. Finally, I will consider an objection arising from thought experiments in which various things are glued to, or otherwise bonded to, organisms. I confront still more objections in the next chapter.

Preliminaries

It goes without saying that material objects are things, but while that is so, it is also true that some things are not material objects. Among the things "thing" refers to (at least arguably) are properties (such as redness), events (e.g., the inauguration of Abraham Lincoln), numbers (e.g., the number 1), and classes and sets (such as the set of words that begin with the letter "t"). "Thing" may also refer to an object, and while the terms "thing" and "object" come close to being synonymous, "object" seems to cover less territory than does "thing," as is suggested by the fact that, at least in some contexts, we tend to reserve "object" for concrete individuals. I will not discuss the nature of everything that counts as a "thing."[1] I will consider only a small patch of the territory covered by "thing" – only *some* things, only *some* of what there is, namely material (or physical) objects such as tables, boulders, and raccoons, which typically I will simply call "objects."[2]

I should point out, right off the bat, that I intend to develop the answer to my question (What is a material object?) by replacing it with another. The question I will replace it with is roughly: When (by virtue of what) do things compose (or make up) a material object? I will attempt to identify the conditions that are necessary and sufficient for some things to compose an object. If I can supply these conditions, I can also answer certain related questions about objects. For example, suppose, as seems evident, that some things make up a composite object if and only if that object exists. Then once we identify the conditions under which some things compose an object, we will have a useful answer to the question: What is it for a composite object to exist?

I intend my account to be principled. I take it to be consistent with plausible assumptions about objects, such as the following:

- the part–whole relationship is transitive, and
- different objects cannot be made of the same constituents at the same time, except in the sense that some objects are parts of others.

However, I should emphasize at the outset that the views I offer are rough. Worse yet, I do not attempt to do justice to the (large and burgeoning) literature on the metaphysics of objects. There, one finds ideas ranging from the extreme eliminativist view that the only objects are simples (simples are objects that have no parts other than

[1] According to W. V. O. Quine (1948), to be is to be the value of a variable. Equivalently: to be a *thing* is to be the value of a variable. On its face, "to be is to be the value of a variable" suggests that the existence of things is dependent in some way on language or on formal systems of logic, which is a view I reject. Quine did too; he was not telling us what there is, but rather what our theories commit us to (which is consistent with the thesis that the *grounds* for concluding that things exist is that swatches of our most successful scientific theory quantify over variables that take those things as values). This seems to be his view in the last few paragraphs of "Two Dogmas" [Quine, 1951]).

Quine's slogan reminds us that we use the term "thing" for *any* of the items we speak or write about.

[2] If we restrict the term "object" (as opposed to "thing") so that it refers solely to material objects, as I want to do, then the term "object" is a count noun. Van Inwagen treats "object" as the most general count noun (van Inwagen 2019, p. 176, note 6). I would quarrel with this treatment if it commits us to the claim that if any bona fide count noun applies to some thing or things then "object" applies to that thing or things. (I will raise doubts about that claim in Chapter 2.) In any case, I take it that this usage leaves open the possibility that some objects are not material, and I may as well repeat that in this book I will be using "object" as an abbreviation for "material object."

themselves – they are objects that lack *proper* parts) arranged in a multitude of ways – chairwise, catwise, dogwise, and so forth – to the extreme permissivist view that any combination of things makes up an object. (Some eliminativists – the moderates – allow for exceptions; for example, Peter van Inwagen, whose book *Material Beings* [1990] greatly influenced the view of objects I sketch here, considers organisms to be composite material objects. He also thinks that they are the only composite material objects. My own view is a more moderate form of eliminativism.) I will aim to supply just enough detail to make claims I defend in later chapters intelligible. I will hope that what I say strikes the reader as being coherent and plausible and that it also derives support from the ways it helps us to solve puzzling problems, such as those involving splitting and transplanting brains, which I discuss in later chapters.

Material Objects

Very roughly, I suggest, a composite (material) object is something made of things that have physical features that enable those things to resist coming apart. "Physical" features, such as mass, shape, and momentum, are the properties and relations that are investigated by the physical sciences. An example of a composite object is an organism. Another example is a watch. By contrast, dust particles that are currently scattered across the universe compose no object just now. It may be that objects not made up of other objects – say one of the atoms posited by Democritus – could not come apart, could not disintegrate (which is not to rule out the possibility of their ceasing to exist). If such things exist, they count as objects as I understand them, albeit as non-composite objects, of course. But perhaps all objects are composite objects. Maybe all objects are made of "gunk," which David Lewis defined as "an individual whose parts all have further proper parts" (1991, p. 20). Maybe some are gunky; maybe there is no gunk. (It also seems conceivable for an object to be made up uniformly of some sort of material such that each gob of it is qualitatively similar to the next – the same material all the way through, all the way down – much as a pat of butter is the same stuff as the stick from which it is sliced.) I will have nothing more to say about objects that are not composite. My discussion will concern *composite* objects.

Although objects resist disintegration, what composes them may change considerably over time: an object composed of some things at one time may be composed of different things at another time. Take my truck, for instance. Earlier today, I took it in for maintenance, and the mechanic

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replaced the spark plugs, so what it was composed of yesterday is different from what it is composed of now. Eventually, I will want to address what needs to be true of an object if it is to undergo changes in composition.

First, however, let us address a simpler question. I just said that, at each time an object exists, it is composed of some things at that time (though possibly of other things at other times). I think we can assume that an object is composed of things at a time *by virtue of* the fact that those things are related to each other in some way at that time. Our first question is: What is that relation? How must things be interrelated at a time for them to make up an object at that time? My watch is currently an assembly of various sprockets, springs, and other doohickeys. It is because these parts are interrelated in some way that they make up something at the current moment. What is that relation?

We can state the question more carefully if we use the letter R as a variable ranging over relations, the letter *x* as a variable ranging over things, and the letter *t* as a variable ranging over times. Following van Inwagen (1990, pp. 26–29), we can use the expression "the *x*s" as a plural variable and the expression "the *x*s compose *y* at time *t*" as shorthand for

> the *x*s are all parts of *y* at *t* and no two of the *x*s overlap and every part of *y* overlaps at least one of the *x*s at *t*.

(I will use the terms "compose" and "make up" the same way. Things overlap when they share a part.) The question, then, is, by virtue of what relation R_c is the following true:

> necessarily, some things, the *x*s, compose an object at time *t* if and only if the *x*s are R_c-related at *t*.[3]

The answer supplies us with an account of *composition*.

Composition

Here is my first pass at an answer to this question:

> *simple bonding*: necessarily, some things, the *x*s, compose an object at time *t* if and only if the *x*s are bonded at *t*.[4]

[3] Compare van Inwagen's Special Composition Question (1990, p. 30).

[4] This seems to be roughly the view that Andrea Sauchelli (2017) takes. Although I reject *simple bonding*, in some other ways Sauchelli's views overlap with mine. Compare Fei Xu's (1997) discussion of "bare particulars" in "From Lot's Wife to a Pillar of Salt: Evidence that Physical Object is a Sortal Concept."

(I add the qualifier "simple" to the term "simple bonding" because, for reasons that will become clear later, I will need to distinguish different sorts of bonding.) In saying that some things are bonded at a time, I mean that due to their physical features (perhaps relations holding among them), each resists (is impeded from) being moved farther apart from the others at that time. (I do not mean to imply that they touch each other.) For example, if, at some particular time, one atom, call it A_1, is chemically bonded to another atom, A_2, and neither is bonded to anything else, then A_1 and A_2 compose an object at that time. If a third atom, A_3, is chemically bonded directly to one of the first two, but not to both, and not to anything else, then A_1, A_2, and A_3 together compose an object: by virtue of the array of chemical bonds, no one of the atoms is easily separated (moved farther apart) from the remaining atoms. We can add that things that are bonded at one time may still be bonded after these things are moved apart a bit, as these things might continue to resist separation even as the spaces between them are increased in size. For example, magnetic force might continue to hinder the separation of some things after they are moved apart slightly. (More on this later.) Of course, the bonds by which objects are composed are not limited to chemical and magnetic forces; nuts, bolts, and screws hold together some of the things that compose my car. To uphold the convention that everything is part of itself, we can stipulate that everything is bonded to itself.

It would be nice if we could make do with the formulation I am calling *simple bonding*. Unfortunately, however, it needs refinement, as can be seen once we notice that it implies that any bonded pair (and any bonded triple and so forth) of things that are among the things that make up an object is also an object. For example, not only do bits of clay that are stuck together compose an object, the bonded bits that make up the bits compose an object. Each object may include within itself a large number of further objects, each distinct from the others. Some may overlap. One may differ from another by as little as a single atom.

To avoid these implications, I suggest we say that (with one qualification I will mention soon) the things that compose an object at a time include *everything* that is bonded to any of those things at that time. A smallish bit of clay embedded in a clay statue is not an object on its own because that bit is also bonded to *other* bits. An assembly of just two atoms does not make up an object if either is also bonded to another – a third – atom. Instead, the object the atoms help make up extends outward to include everything bonded to anything bonded to the two atoms. To capture this idea, let us say that some things, the *x*s, are *maximally bonded* (in a preliminary sense

I will need to modify soon) if and only if the *x*s are simply bonded *and* the *x*s include everything simply bonded to any of the *x*s (compare van Inwagen 1990, p. 63). (That is, the *x*s are simply bonded, and there are no *y*s such that the *y*s are simply bonded and the *x*s are properly among the *y*s.) Then we can revise the simple bonding formulation as follows:

> *preliminary version of maximal bonding*: necessarily, some things, the *x*s, compose an object at time *t* if and only if the *x*s are maximally bonded at *t*.

Without a doubt, the account could use further refinement, but I will mention just two qualifications (which themselves could be clearer!) that seem necessary. (Readers losing patience with the refinements may wish to skip down to the next section.)

The first qualification I have in mind concerns the fact that some bonds are too weak to count as holding an object together. (In referring to the strength of the bonds between two things, I mean to refer to the combined force of all of the bonds between them.) Presumably, the relevant bonds must exceed some threshold in strength, but I will not attempt to specify what the cutoff point is. Strong bonds hold much of our planet (much of its outer crust, for example) together. Many objects on or near its surface are held in place only by gravity. It is not clear to me whether the objects resting on the planet's surface, together with the remainder of the planet, form an object (whether these objects are parts of the object we call Earth). Nor is it clear to me whether, together, Earth and its satellite compose an object, or whether Earth and various other bodies compose an object called a galaxy, or a universe, if held together only by weak gravitational force.

A related problem arises once we consider that some bonds holding things together are substantially stronger than others. Very strong bonds hold atoms together; the same goes for molecules. Imagine a universe containing nothing but three solid iron, qualitatively identical, cube-shaped magnets, each 1 inch on a side, clinging together in a row, held by strong magnetic force. None of the cubes would be an object in itself, according to the preliminary account of composition we have formulated. Instead, the universe we are picturing would contain one 3-inch-long rectangular object composed entirely of iron atoms. Yet, it seems that each cube *is* an object and that it is a proper part of the larger, rectangular object. Consider any one of the cubes. The bonds holding that cube itself together – the bonds among the iron atoms of which it is composed – are much stronger than the magnetic bonds holding the three cubes together. Hence each cube is an object in its own right, even while being part of the larger rectangular object.

Apparently, the relationship between an object and its parts hinges on the strength of the bonds among those parts. We can exploit this point to refine our account a bit further. (The *stronger than* relation is transitive, so there should be no failure in the transitivity of the part–whole relation.)

So how should we qualify the account? My suggestion is this. Let's say that some things, the *x*s, are maximally bonded if and only if the *x*s are simply bonded, and they include everything whose bonds to any of the *x*s are at least as strong as the weakest bond among the *x*s. While we are at it, we can add some details concerning the proper parts of objects. Consider the following conditions:

(1) The *x*s are maximally bonded in the qualified sense: they are simply bonded, and they include everything whose bonds to any of the *x*s are at least as strong as the weakest bond among the *x*s.
(2) The *y*s are among the *x*s.
(3) The bonds among the *y*s are significantly stronger than the bonds among some other *x*s.
(4) The *y*s include everything bonded to any of the *y*s at least as strongly.

If condition (1) holds, then the *x*s compose an object. If all four conditions hold, then not only do the *x*s compose an object, the *y*s compose an object as well, and the object that the *y*s compose is a proper part of the object that the *x*s compose.

We can repackage these claims into a refined account of composition as follows:

maximal bonding
- necessarily, some things, the *x*s, compose an object at time *t* if and only if the *x*s are simply bonded, and they include everything whose bonds to any of the *x*s are at least as strong as the weakest bond among the *x*s.
- necessarily, if O_1 is an object that is composed of the *x*s at time *t*, then some things, the *y*s, compose an object, O_2, that is a proper part of O_1 if (1) the *y*s are among the *x*s; (2) the bonds among the *y*s are significantly stronger than the bonds among some other *x*s; and (3) the *y*s include everything bonded to any of the *y*s at least as strongly.

On this view, each magnetic cube in our example is an object in its own right, even though it clings to other cubes. At the same time, the tri-part assembly of cubes is an object, as the cubes are bonded together but not to anything beyond the trio. However, no two of the cubes, taken together, compose anything, as each cube in each pair is bonded with another cube as strongly as it is bonded to the cube in its pair. Call the cubes C_1, C_2, and

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C_3. Say C_1 clings to C_2, and C_2 to C_3. Unlike that of C_1, C_2, and C_3, the combination of C_1 and C_2 is not an object because the bond between C_1 and C_2 is not stronger than the bond between C_2 and C_3. Aside from things (such as iron atoms) smaller than the cubes, the described universe contains only four objects: C_1, C_2, C_3, and the object they compose.

Now consider a universe like the one just described, except that, in it, a small piece of paper is glued to C_3. Because (as we can stipulate) the bond between the piece of paper and C_3 is far weaker than that between the cubes, together C_1, C_2, and C_3 still compose an object in exclusion of the bit of paper. Nevertheless, C_1, C_2, C_3, and the paper compose an object as well. Similarly, when a cotton ball is glued to a massive metal safe, the object that is the safe remains in existence, while at the same time, a new object comes into existence, composed of the safe, glue, and cotton ball.

Persistence

I have been addressing the question: What does it take for things to compose an object at a particular time? But answering that question gives us only part of the picture of the composition of an object, for presumably objects that are made up of some things at one time may be made up of other things at other times. To complete our picture, we need to address a further question, namely, by virtue of what relation R_p is the following true:

> Necessarily, an object O_1 existing at some time t_1 is identical to an object O_2 existing at a later time t_2 if and only if O_1 is composed of the *x*s at t_1 and O_2 is composed of the *y*s at t_2 and the *x*s and *y*s are R_p-related?[5]

The answer to this question will give us the *persistence conditions* for composite objects. In other words, it will provide us with an account of *persistence*.

We can get a head start by taking advantage of work done in the previous section. If the account of composition laid out there is correct, then the account of persistence must conform to it. What we say about the persistence of things over time must conform to what we say about their composition at each time. This assumption, together with our account of composition itself, implies that at every moment a composite object exists, it is composed of things that are maximally bonded.

[5] Note that the relation R_p is not the relation involved in composition. I designated the latter as R_c.

I would make several further claims about persistence. If an object is composed of the *x*s at time t_1, it will remain in existence from t_1 to a subsequent time t_2 and will be composed of the *y*s at t_2 if any of the following conditions is met:

(1) The object's composition does not change:
  (a) the *x*s remain maximally bonded from t_1 through t_2, and
  (b) the *y*s are identical to the *x*s.

(2) The object loses some components and does not gain any others:
  (a) some things, the *z*s and the *v*s together, are identical to the *x*s,
  (b) the quantity of *z*s is small relative to the quantity of *x*s,
  (c) at some time during t_1 through t_2, each of the *z*s ceases to be bonded to any of the *v*s (by the time t_2 comes around, none of the *z*s is bonded to any of the *v*s),
  (d) the *v*s remain bonded from t_1 through t_2,
  (e) no things that are not among the *x*s come to be bonded to the *x*s during t_1 through t_2, and
  (f) the *y*s are identical to the *v*s (the *y*s are those of the *x*s that are still bonded at t_2).[6]

(3) The object loses none of its components but does gain others:
  (a) at each time during t_1 through t_2, the *x*s remain bonded,
  (b) some things, the *u*s, are not among the *x*s,
  (c) the quantity of *u*s is small relative to the quantity of *x*s,
  (d) the *u*s are (all of the) additional things that come to be bonded to the *x*s during the interval t_1 through t_2, and they remain bonded to the *x*s through to t_2, and
  (e) the *y*s are identical to the *x*s and the *u*s together.

(4) The object loses some components and gains others:
  (a) some things, the *z*s and the *v*s together, are identical to the *x*s,
  (b) the quantity of *z*s is small relative to the quantity of *x*s,
  (c) at some time during t_1 through t_2, each of the *z*s ceases to be bonded to any of the *v*s (by t_2, none of the *z*s is bonded to any of the *v*s),
  (d) the *v*s remain bonded from t_1 through t_2,
  (e) some things, the *u*s, are not among the *x*s,
  (f) the quantity of *u*s is small relative to the quantity of *x*s,

[6] A refinement is needed here, to accommodate the fact that an object cannot be reduced to one of its proper parts. Condition 2 holds except in the case that, at time t_1, the *v*s themselves compose an object.

(g) the *u*s are (all of the) additional things that come to be bonded to the *v*s during the interval t_1 through t_2, and they remain bonded to the *v*s through to t_2, and
(h) the *y*s are identical to the *v*s and the *u*s together.

These points about the things that compose an object at different times will help me to shape the account of persistence I seek, but to complete the account and to ease the discussion to come, I will need to coin some terms.

I will say that the *y*s *incrementally replace* the *x*s over the interval of time t_1 through t_2 if and only if

- the *x*s are maximally bonded at t_1, and
- any of the four above-mentioned conditions – 1, 2, 3, or 4 – is met. (Given 1, the *y*s may replace the *x*s even though they *are* the *x*s.)

I will also say an object undergoes *incremental changes* when the things that compose it undergo any of these four sorts of incremental replacement. I will not apply this term – "incremental change" – to other sorts of changes an object may undergo, whether those changes are gradual or not. For example, it will not apply to qualitative changes such as variations of color or shape. An object that is a billiard ball does not undergo an incremental change solely by coming to be a slightly darker shade of blue, or by taking on a color that is slightly closer to purple, or by becoming slightly less spherical.

Using this new terminology, I can sum up my remarks about persisting objects this way: An object that exists at some time remains in existence when its components undergo incremental replacement (when the object changes incrementally) over some interval of time. But if that is true, then an object will also remain in existence when its constituents incur a *series* of incremental replacements. Such a series occurs when the *x*s that compose some object at some time are incrementally replaced by the *z*s, and then the *w*s incrementally replace the *z*s, and so on. When such a series begins with the *x*s and leads up to a replacement by the *y*s ending at some time *t*, let us say that, at *t*, the *x*s *give way to the ys through a series of incremental replacements* (or more simply: the *x*s *give way to* the *y*s at *t*).

I can now offer an account of persistence, which we may call the *incrementist* account:

> *incrementism*: necessarily, an object O_1 existing at some time t_1 is identical to an object O_2 existing at a later time t_2 if and only if O_1 is composed of the *x*s at t_1 and O_2 is composed of the *y*s at t_2 and the *x*s give way to the *y*s at t_2.

Equivalently: the object that the *x*s compose at t_1 is the object that the *y*s compose at t_2 if and only if the *x*s give way to the *y*s at t_2.[7]

Incremental Change

I said that objects may undergo incremental changes – their parts may undergo incremental replacement – over time. Let's see if I can make the idea of an "incremental" replacement clearer.

In stating what is involved in incremental replacement, I said that an object composed of the *x*s may survive a loss of constituents if the quantity of lost constituents is "small in proportion" to the quantity of original *x*s. I also said that an object composed of the *x*s may acquire constituents when the *x*s come to be bonded to a quantity of additional things that is "small in proportion" to the quantity of *x*s. The words "small in proportion" could be clearer, and so could the quantities I mean to compare.

Consider a universe that, at some time *t*, contains (1) a row of 100 qualitatively identical cube-shaped magnets made of solid iron that cling together, and (2) one additional magnet that is qualitatively like the others but is not near them. Together, at time *t*, the 100 magnets compose an object, of which the 101st is not a part. If that 101st magnet is now moved over and attached to the others, then the object that consisted of 100 magnets at time *t* will have grown larger. Its constituents will have been augmented incrementally. What is added is small in proportion to what it was added to. (It isn't merely that a 100-magnet-long object exists at time *t*, and then, a bit later, an even longer object exists. Our story concerns an object that comes to have an additional constituent: the object before the 101st magnet is added to it is one and the same object as the object that gained the 101st magnet as a constituent.) If instead of attaching the 101st magnet we removed one of the original 100, the object would have been diminished incrementally.

My explanation of incremental replacements refers to two quantities: that of the *x*s and that of what is added to or taken from the *x*s. It makes sense to speak of these quantities only if certain conditions hold. If we assume that all bonded things and all things that augment them have mass, we can define incremental augmentation in terms of *mass*, as follows: An augmentation is incremental if and only if the mass of what is added is

[7] Note that an object that is composed of some things, the *x*s, at one time might come to be composed of other things, the *y*s, at a later time and then, still later, it might come to be composed of the *x*s once again. These might be cycled through an object several times.

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small in proportion to the mass of what is augmented. Similar remarks apply to incremental diminishment: A reduction is incremental if and only if the mass of what is removed is proportionately small.

When is the mass of what is removed small enough to count as an incremental diminishment? There is no determinate answer, I would think. It seems clear that the mass of what is removed is small enough if it equals, or is less than, 1 percent of the mass of the object that is reduced. It also seems clear that the diminishment is incremental *only* if the reduction is less than 50 percent. As to whether the mass of a diminishment counts as incremental if it is 10 or 30 or 40 percent of the mass of the object that becomes smaller, I cannot say. (It cannot be arbitrary to limit reductions to less than 50 percent; unless we do, our account will have consequences that are impossible, such as one object becoming two.) Similar indeterminacy arises in the case of incremental augmentation. It is clear that the mass of an addition is small enough to count as incremental if equal to or less than 1 percent of the mass of what it augments. It is also clear that it must be less than 100 percent (or else it will be possible for two objects to become one).[8]

Note that the account on offer imposes no restrictions on how quickly changes may occur if they are to count as incremental. Imagine that mechanics work on my truck several times during the day, and although each time they work on my truck, the mechanics change its components very little, they end up replacing 60 percent of it by the end of the day. Then they could just as easily have slowed down and taken two days to make the same incremental changes (and charged me more), or worked faster and done the job in an hour.

[8] I doubt that the incrementist account applies to subatomic phenomena, such as gluons. I would be happy if it applies higher than at the atomic level. As for whether it applies at the atomic level (whether it describes the conditions under which things compose individual atoms, and under which individual atoms persist), I hold out some hope, but there are plenty of worries. Just one worry is that, for an atom with enough protons, the loss of a proton may constitute an incremental change, yet take that atom from one place on the periodic table to another, since an atom's number of protons determines its classification as an element. Can an atom persist through an elemental transformation? I am inclined to think so, on the grounds that an atom could persist after gaining or losing a neutron, and the mass of a neutron is only slightly greater than that of a proton. Gaining or losing a neutron should have roughly the same impact on whether an individual atom persists as gaining or losing a proton does. However, I can imagine someone taking the view that an atom's place on the periodic table is essential to it, which suggests that protons and neutrons have very different implications for an atom's persistence. (Chemists will say that gaining or losing a proton changes the "identity" of an atom, but in doing so they mean to say that the atom will be *classified* differently. A change in the number of its protons is of special interest because it sharply affects the chemical properties of the atom – how it reacts with other chemicals. A change in the number of neutrons typically has little effect on an atom's chemical properties.)

Let me further clarify incremental change by contrasting it with (what I will define as) fission and fusion. I will say that two or more objects *fuse* if and only if they (or the things that compose them) come to compose an object O that did not exist prior to their merger. An object O *fissions* if and only if the things that compose O come to compose two or more objects and thereby end O's existence. For example, pressing together two equally massive wads of clay results in their fusion. It is an incremental change for neither, so, in coming to compose an object, they thereby bring it into existence. When an object O gains or loses a part as the result of O's incremental change, O and the part neither fuse nor fission.

An object O might come to be "part" of others in two importantly different senses. Let us say:

- O is *assimilated* by one or more objects if and only if the things that compose O come to be part of the other objects, thereby ending O's existence.[9]
- O is *subsumed* by another object if and only if O becomes a proper part of it (so O remains in existence).

When an object O undergoes an incremental augmentation, O will assimilate or subsume some things. If a small wad of clay is pressed into a wad of clay that is much larger (but equally dense), the latter assimilates the former. If a small bit of metal is glued to a large block of wood, the latter subsumes the former. Fusion also involves assimilation or subsumption, but it is a newly formed object that assimilates or subsumes the objects that fuse.

Incrementism could use further refinement but is adequate, I hope, for the work I expect it to do. In the next several sections, I will attempt to clarify the account further by bringing out some of its implications. (At this point, readers who want to follow the main thread might prefer to move on to the next chapter.)

Density and Hardness

Earlier, in discussing the composition of objects, I said that the bonds holding an object together must meet a minimum threshold of strength. However, their strength may change, and remain above the minimal threshold. How densely packed the molecules composing an object are may also change over time, as some such changes will be consistent with the

[9] Contrast the way van Inwagen defines "assimilation" (1990, p. 96).

fact that their bond strength remains above the threshold. Let me elaborate a bit on this point.

When the bonds holding together the components of one object are significantly stronger than the bonds holding together the components of a second object, let us say that the former is *harder* than the latter (and that the latter is *softer*). Objects normally survive some degree of hardening and softening. I am inclined to agree with Descartes that a piece of wax (or metal) normally survives when the molecules that compose it change their state from that of a solid to that of a liquid (involving a weakening of bonds) or go from being liquid to being solid (involving a strengthening of bonds).

Although the persistence of an object is consistent with its transitioning from a liquid to a solid state, the transition to a gaseous state is another matter, as gas particles spontaneously move away from each other, and disperse. The behavior of gas particles is just the opposite of the behavior of things that compose objects. (Nevertheless, an intriguing question arises concerning an object O that is currently in a liquid state. If heated, the molecules that compose O may come to be a gaseous state. O will not exist while these are in a gaseous state, but if they cool enough to liquefy, does the very same liquid object O pick up its existence where it left off? More on this sort of question in the section called Disassembly and Reassembly, later in this chapter.)[10]

Shape Shifting

An object survives changes in its shape, changes brought about when its constituents are rearranged, as long as these remain bonded together. The changes may be dramatic and sudden. By way of illustration, consider an object, discussed earlier, that consisted of a row of 100 magnets. If these remain bonded while their positions are shifted, the object composed by the magnets remains in existence. Something similar occurs in the case of a piece of clay or Play-Doh, or Descartes's piece of pliable beeswax, whose shape may be changed considerably from one moment to the next.

[10] Further complications would arise on the assumption that an object's persistence depends directly on whether it undergoes various changes in volume. If an object O consists of a small lead weight glued to a large cotton ball, do we greatly diminish O's volume if we separate the weight from the ball? Do we instead greatly diminish O's mass? Curtis Brown asks a related question: if the molecules in a tiny region of Wad are extremely dense but together comprise half of Wad's mass, does removing them from Wad really end Wad's existence? Cases like this may suggest that whether an object undergoes incremental change depends on the mass density of the things in various regions of that object. But I will not pursue the issue.

In fact, incrementism implies that very little is essential to objects. Shape is just one of their contingent features. A feature is contingent to an object just if the object could exist (could have existed) without having that feature. Its essential features are those without which it could not exist. On the incrementist account, the essential features of objects concern their composition at a time and over time, and nothing else, so objects are quite versatile.

Bodies of water, such as rivers, are examples of extreme shape-shifters. Because water molecules in bodies of water are bonded (the molecules cling to each other, which is why water floating in space will form a sphere), it is as easy to step into the same river twice as it is to step into the same lake or onto the same moving snake more than once. A river is made up of a long, sinuous body of water that is fed by runoff from rain and melting snow and ice and that flows into a larger body of water, such as a sea. It seems plausible to say that a river is actually an extension of the sea into which it flows, but we tend not to. Let that go. In any case, the water that is added to a river at a time, or lost at a time, is small in proportion to the total quantity in the river as a whole, so it changes incrementally. We might say the same about waterfalls, assuming that the water in the fall is bonded. The amount of water that is added and lost at a time is small in proportion to the whole waterfall.

Disassembly and Reassembly

Incrementism is not consistent with some widespread views concerning taking objects apart then putting them back together again. Even if merely in passing, I had better say something about this fact.

Many objects that are instruments are disassembled for convenient storage. The parts are then reassembled before being put to use. Objects that are automobiles or watches are dismantled for thorough repair and cleaning, and these parts are then reassembled. (Why am I using the odd locution "objects that are automobiles or watches" instead of the words "automobiles" or "watches"? More on this later.) When the parts are reassembled, does it bring back the original object? Is the automobile *itself* reassembled? That is, does the automobile stop existing upon being completely disassembled, then return to existence when the parts are reassembled, leaving a gap in its existence? If so, the incrementist account will need modification.

Incrementism does allow for something we might call the *incremental* disassembly and reassembly of an object. For example, an object that is a car continues to exist after a small part (a part with a relatively small mass) of it is removed, followed by another small part, and another. It remains in existence when these are reattached, small piece by small piece. But if roughly half of it is suddenly separated from the other half, it fissions, which ends its existence. Similarly, if the object is whittled down, incrementally, to (say) the motor, then the sudden removal of half of *that* ends the existence of the remaining (motor-sized) object. Ordinarily, people are not fussy about the proportions of the things that are disassembled and reassembled. The commonsense view is that (something like) the following principle is true:

disassembly: objects may be taken completely apart then reassembled.

Incrementism forces us to be quite selective. It implies, for example, that if we attempt to begin our disassembly and reassembly of an object that is a car by suddenly separating it into two equal halves, we will fail, as division ends its existence, and bringing the halves back together results in the existence of an object that is distinct from both the original car and from each of the halves.

Should we side with the commonplace view over incrementism? Perhaps, but I will not here assume that the disassembly principle holds, and in what follows I will generally assume it does not. (If you think that a liquid object can be brought back into existence after an interval of time during which its molecules are in a gaseous state, you are likely to side with the commonplace view. The eerie behavior of hydras, discussed in Chapter 3, may also convince you, assuming you think hydras can reassemble – not merely duplicate – themselves.)[11]

[11] If we did go with the commonplace view, we would need to modify incrementism to allow for the possibility of gaps in an object's existence. We would also have to deal with some formidable obstacles to the disassembly principle. (I thank Eric Olson for helpful remarks about this principle.)

For example, we would need to solve (Thomas Hobbes's version of) the Ship of Theseus puzzle (Hobbes 1655, II.11.7). Suppose we accept incrementism, and say that an object will persist over time if we gradually swap some of its parts with new parts. Say we do this to a wooden ship, the USS *Theseus*, starting on the first day of 2020, replacing one of its constituent planks with a new one on one day, then a different part of the ship on another day, and so forth, until after a year's time the ship we end up with is composed of none of the things it was composed of back on January 1, 2020. Now suppose that I collected all of the parts that were discarded over the course of the year 2020, and I hire a crew to assemble them exactly as they were on the first day of 2020. Call the ship my crew assembles on January 1, 2021, the USS *Hobbes*. Obviously, the USS *Hobbes* is not identical to (not the same ship as) the USS *Theseus*, although, on the day I finish assembling it, it is not only indistinguishable from the USS *Theseus* as it was on the first day of 2020, it is composed of the very same things, right down to the very same molecules. So if we deny that the USS *Theseus* continues its existence as the USS *Hobbes*, don't we have to reject the disassembly principle?

Gluing Cats to Kids

If I glue a cat to a child, would this bring an object into existence – an object composed of the cat and the child, or rather an object composed of the cat molecules, the child molecules, and the glue molecules? It would if incrementalism is correct, but is this something we can accept?

Peter van Inwagen appeals to this sort of example (he imagines joining people together in various ways) as a means to reject the idea that bonding (of any sort) among things suffices for them to compose a material object. In his view, what I did to the cat and the child might annoy the cat and the child and its parents, but it brings no new material objects into the world. There is no such thing as the cat-glued-to-the-child. If van Inwagen is correct, then nothing like incrementism can be correct.

However, I do not think his objection is compelling. It seems quite plausible to say that gluing together artifacts, or inanimate things, results in new objects: gluing together bits of pre-formed plastic results in a model airplane, and binding bricks with mortar results in a wall. Anyone who accepts this view (which van Inwagen would not) probably will also accept the view that gluing together organisms results in new objects. Why should we be reluctant to think that we could make an object, say a makeshift hut, by gluing together, in an appropriate way, the kids in the local kindergarten school and/or the cats roaming the neighborhood? I am inclined to think we can explain away any reluctance we might have without rejecting the view.

Well, we *would* have a problem if our basis for accepting the disassembly principle were something like the following principle:

> *same parts*: an object composed of the *x*s at some time is identical to the object the *x*s compose *any* time the *x*s are assembled.

What we said about the USS *Hobbes* implies that the same parts principle is false.

If we reject the same parts principle, we might still claim that composite objects can be reassembled in certain circumstances, even though, in the *Hobbes* case, my crew did not reassemble the USS *Theseus*. However, further problems arise. Consider a variant of the Theseus Puzzle. Suppose that on January 1, 2020, the crew of the USS *Theseus* took their ship completely apart, and gave the parts to me. Gradually over the course of the next year, part by part, I ask the crew of my own ship, the USS *Luper* (which has the same design as the USS *Theseus*), to swap these out with the parts of my ship, so that, a year later, on January 1, 2021, my ship is composed of the very parts the USS *Theseus* was composed of just before it was disassembled on January 1, 2020. Now suppose that, the same day, January 1, 2021, I have my crew take *my* ship completely apart (maybe, inspired by what Carlos Fitzcarrald did in the Amazon jungle, I want my ship transported to the other side of a mountain). Later I have my crew reassemble the parts. Has my crew reassembled the USS *Luper*? Have they reassembled the USS *Theseus*? The one claim is no more plausible than the other is, and both cannot be true, so neither is. If we want to accept the idea that composite objects may be disassembled and later reassembled, we will have to rule out such branching cases.

Here are some possible causes of reluctance:

- the belief that organisms such as cats and kids matter, but organisms that organisms compose (such as cat-kids) do not;
- the fact that organisms are cemented together rarely and only briefly;
- the worry that organisms are assimilated by the objects they compose.

Now, it is true that, while we care about cats for various reasons and children for various reasons, we are not much interested in cat-kids. The cat-kid derives any value it has from that of the cat and the child, each of which is better off detached. (In this regard, we might compare the objects that result from gluing together hot dogs and hand grenades, or parachutes and anvils: parachutes and anvils have their uses, but the glued-together-combination – not so much.) It is also true that the cat is unlikely to remain glued to the child for long, if for no other reason than that anyone who came across a cat-child would separate the two. But why should we think that objects must last? A final point is something I will not be able to establish until later in the book, namely that, while organisms may come to compose an object, they are never assimilated into the object they compose.

Summing Up

Let's review. We have clarified what it is for a composite object to exist at a time and over time by analyzing the conditions under which things compose it at a time and over time. Some things, the *x*s, make up an object, O, *at* a time t_1 if and only if the *x*s are maximally bonded then (the *x*s are simply bonded and include everything simply bonded to any of the *x*s). The object O that is composed of the *x*s at time t_1 may be made up of other things at a subsequent time t_2. It is made up of some things, the *y*s, at t_2 if and only if the *x*s give way to the *y*s at t_2. Over time, objects may change only incrementally (unless we allow for the possibility of an object being disassembled then reassembled). Incremental changes are ones in which the mass of what is added (removed) is small as compared to the object's mass before the addition (removal).

I hope to have provided a plausible and reasonably clear account of material objects. However, I am mindful that it faces formidable objections. In the next chapter, I will attempt to fend off some of these.