The individuality of artifacts and organisms.[1]

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1. Introduction

Advances in molecular biology have made the artificial selection of biological functions a familiar part of contemporary civilization: Just as we can whittle a stick into a spear, biologists can now modify an organism to become a factory for fuel or pharmaceuticals. The success of genetic engineering may encourage us to see the distinction between artifacts and organisms as a vestige of our benighted vitalist past. However, in spite of the power of contemporary bio-engineering, our intuitions concerning the difference between organisms and artifacts still have some content. This paper argues that there is a meaningful difference between organisms and artifacts, that this difference involves the character of their individuality.

One standard approach to biological individuality regards it as coextensive with the functional interdependence of the parts of an organism. Organisms vary with respect to their level and kind of interdependence. Given that organisms exhibit such variety, some philosophers have concluded that biological individuality "comes in degrees."

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(Sober 1993, Guyout 1987, Ereshefsky 1991) According to Sober and others, an ivy plant has less individuality than a gazelle. Unlike a gazelle, an ivy plant can be cut in half without killing it. (1993, 151) The parts of the ivy plant depend on one another in ways unlike the interdependence of the parts of a dog or a shark. In most real biological cases, the degree of functional interdependence cannot be known apriori, but instead, varies depending on the kind of organism under consideration.

Sober's observation highlights the important difference between individuality and identity. While their degrees of individuality are different, clearly, ivy plants and gazelles are identical with themselves in precisely the same way. There can be no objective vagueness with respect to identity, but there can be many kinds of vagueness with respect to individuality.[2]

The individuality of artifacts is also related to their functional properties. However, unlike an organism, an artifact's individuality is (for the most part) determined by the function which the designer selected in the artifact's production rather than the functional interdependence of its parts. In both cases, individuality is a historical property and in both cases the parts may be functionally interdependent to some extent. But for artifacts, this interdependence is not what makes, for example, a spear the individual that it is. Instead, the interdependence of its parts is in the service of the functions for which the spear was designed. No such *higher* purpose or function exists for an organism.

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[2] Gareth Evans demonstrates the problem with the claim that there exist vaguely identical objects via in his 'Can There be Vague Objects' (1978).

Claiming that the intention of the creator and the individuality of the artifact are related is relatively uncontroversial.[3] In the case of the organism, no such relation exists. The analogical application of the language of design to evolutionary history has a complicated role in scientific inquiry. (See Lewens 2004) Whatever the potential heuristic value of design talk in evolutionary biology might be, I will argue that it is a mistake to confuse organisms with artifacts insofar as we are concerned with the individuality of organisms

In this paper, the assumption that organisms and artifacts have different kinds of individuality is defended via an analysis of the problem of the creation and destruction of individuals. In conclusion, I will address the status of animals whose functions have been intentionally selected via genetic engineering.

2. Counting ships and counting animals

The problem of understanding the creation and destruction of individuals is equivalent to what Aristotle called the problem of substantial change. He articulates the problem in *On Generation and Corruption*.

Aristotelian substances are described as undergoing changes of four different kinds. These four types of 'change' involve two types of event. In addition to events of 'alteration'-- changes in the quality, quantity or place of an object-- there are events of 'coming to be' per se. Aristotle criticizes most of his predecessors for misunderstanding

[3] By claiming that the existence of some relationship between the intention of the creator and the individuality of the artifact is relatively uncontroversial, I do not mean to imply that the nature of that intention is simple or unproblematic. As pointed out by one referee for this paper, the idea of authorial intention is highly controversial. See Huneman (forthcoming) for a recent paper which is directly relevant to the problem of understanding intentionality in the context of artifacts and artworks.

the difference, noting that those "who construct all things from a single element, must maintain that "coming to be" and "passing away" are 'alteration.' For they must affirm that the underlying something must always remain identical and one; and change of such a substratum is what we call 'altering'." (BK 1 Par 4.) There would be no genuine novelty, no genuine 'coming to be' without the possibility of more than one 'element' or fundamental kind in the basic ontology. Thus, in more contemporary terms, the claim that there exists only one kind of fundamental stuff is incompatible with ontological novelty. Since Aristotle assumes that there are distinct substances; dogs, horses, trees, the sun etc, the problem of substantial change is a pressing one. Again, notice that if one denies that nature is divided into distinct substances or kinds, the problem of substantial change disappears. When we examine the Ship of Theseus problem below, we shall see that many recent attempts to address the problem of creation and destruction are equivalent to denials that there really is a problem.

Rather than asking how (or whether) things persist through change, the problem of substantial change asks how something can start or stop being identical with itself. The Ship of Theseus problem brings the most relevant aspects of this problem into focus nicely. This section describes the problem, Section 3 outlines some prominent solutions to it, and Section 4 compares how these solutions fare in the case of living things as opposed to other kinds of composites.

The problem of the Ship of Theseus begins with the question of whether a renovated composite, like, for example Theseus' ship, is numerically identical with the ship as it was prior to a change in its parts. Common sense tells us that an artifact can be modified while maintaining its identity; if it means anything to talk about the diachronic

identity of a composite (and, of course some philosophers have denied that it does) then it seems reasonable to believe that a composite can undergo some changes in the composition of its parts. Against this common sense position, mereological essentialism as defended by, for example, Chisholm (1976) involves the denial that an object can undergo a change of its parts. Since mereological essentialism is not relevant to the question of whether animals are artifacts, for the remainder of the paper I will assume that some version of the commonsense view of the identity of composites is true.

Given the commonsense account of diachronic identity for composites, we might ask what degree of change is permissible. For example, one might consider setting some limit as to how many of the original parts could be replaced before the renovated artifact or organism would fail to be identical with the original. For instance, one might allow only a certain portion of the ship of Theseus to be replaced, say no more than 50 %. At this point we face the following challenge: We allow that ship A, with 100% original parts is identical to ship B with 51% originals but not ship C with 49% originals. Since the composition of ships B & C differ by only a small portion while A and B differ more significantly, the arbitrariness of the proposed boundary is evident. This arbitrariness holds mutatis mutandis for any point we stipulate as the dividing line beyond which replacement of parts is not permitted without loss of identity. Thus, we seem compelled to allow that a ship can undergo even a complete replacement of its parts while still remaining the same ship. This conclusion comports with our view of organisms which we ordinarily understand as constantly exchanging parts with their environment. Similarly, an artifact (like a vintage car or an aircraft) can be maintained and renovated while remaining, in some sense, the same artifact.

As Hobbes first noted, this conclusion opens the possibility of the following puzzle: Imagine that unbeknownst to us a group of thieves have been taking the original parts to a warehouse where they have busily reconstructed the ship from its salvaged original parts gathered over time from the site of our renovation effort. If we accept the argument from the transitivity of identity above, then we conclude that the renovated ship is identical with the original. However, the thieves point out that their ship was built using all original parts. Thus, the renovated and reconstructed ships both seem like candidates for being judged identical with the original ship of Theseus. The puzzle involves justifying our judgments of identity. Is there a non-arbitrary way of deciding that one ship is really identical with the original? If we are unable to find good reasons for choosing one over the other, are we compelled to readjust our notion of identity for composite objects? Is it possible that both the renovated and restored ships are identical with the original and therefore by the transitivity of identity that these two spatially distinct objects are identical with each other?

3. Solving the problem

The problem is generated by the combination of two basic commitments. The first is the transitivity of identity. The second is the idea that some composites can persist through changes of their parts. Both premises have very strong intuitive plausibility. However, of the two, the transitivity of identity has a more fundamental logical role than the second. Our assumption concerning a change of parts and the identity of the

composite object is where we find most slack for rethinking the problem via alternative accounts of identity and individuation.

Three prominent kinds of solutions have been presented to the puzzle. The first two take what I will call an epistemic tack, the third, by contrast is metaphysical and focuses on the individuality of the object. The individuality of the object is understood in terms of the persistence conditions that underlie the identity of some individual across possible worlds and over time. Without explicitly mentioning the individuality of the ship, E. J. Lowe provides an analysis in terms of its modal persistence conditions. Lowe's approach provides an important supplement to debates concerning problem cases of identity insofar as it opens a line of investigation into the differences between kinds of individuality.

By contrast with an appeal to modal persistence conditions, David Lewis' response to problem cases of the Ship of Theseus variety begins with an epistemic conception of identity. He explains sameness for composites as a relation of "partial indiscernibility". Thus, for Lewis, judgments of identity are always comparisons; the claim that A and B are identical is always restricted to what he calls "respects of comparison" which are somehow associated with the objects in question. (1983, 175) Given an account of sameness in terms of relations of partial indiscernibility, he provides a way of understanding counting which takes care of the problem as follows: Prior to the split, both the renovated and reconstructed ship were, from a certain perspective, there all along overlapping one another in what we had identified as the single original ship of Theseus. We treat the ship(s) as one prior to the split, but we were free to count the ship as more than one. Of course, there is no practical point in counting more than ship prior

to the split, and according to Lewis, we can legitimately count by using these relations of partial similarity. Lewis reasons by analogy reminding us, for example, that some roads are labeled with two names until they split. For instance, "[b]y crossing the Chester A Arthur Parkway and Route 137 at the brief stretch where they have merged, [one] can cross both by crossing only one road." (Survival and identity 1976 p.27) We will return to Lewis' solution below when we discuss examples of reproduction by fission in organisms.

Alternative solutions might propose other kinds of modification with respect to our notion of identity, such that, for example two objects can be identical while not occupying the same region of space-time. The argument here might be, for example that we readily allow for temporal separation of identicals so why not permit spatial separation too? Why not accept that one ship may end up being in two places at once? This solution gains some plausibility given that a large thing can be in a range of places (though perhaps contiguous places) at once. Even contiguity isn't sacrosanct. Think for instance of the many conventional objects, like the United States can have non-contiguous parts. Think also of the biological notion of a super-organism, things like insect colonies, certain kinds of molds etc. Then finally, consider that even a familiar medium sized object is composed of subatomic parts which are separated by relatively large empty spaces.

Presumably, we are resistant to the idea of a ship being identical with another ship on the other side of the bay because of the nature of ships. A ship is a tool which transports people and goods across the water from one location to another. Given that there is only one of me, if I were to attempt to board a ship which had already arrived at

its destination, then the ship would be identical to something which is contrary to its nature as a ship. This might be ok in one respect, after all the ship is likely to have all kinds of properties which are not directly related to its main function. However, in the case of the ship, non-contiguity leads to weirdness. Consider what happens as I leave the pier. I am not attempting to board the spatially non-contiguous ship on the other side of the bay which is identical to the ship I am currently attempting to board. It appears as though I both am and am not attempting to board the ship? The problems here are due, at least in part to the nature of the ship and the nature of an artifact like a ship is related to the functions which it is designed to serve.

We can tolerate non-contiguity in the case of objects like the United States because its nature qua nation state is different from the nature of a ship. Whatever the job of the artifact which we call the United States, it is not essential to it that all its bits be touching.

In my view, reflection on our concept of identity and its role in judgment leads very quickly to a consideration of the natures of the individuals under consideration. To understand what it means to consider the nature of an individual we can turn to the example provided by Lowe in his solution to the problem of the Ship of Theseus. As mentioned previously, Lowe's approach relies on modal properties of the composite objects. He argues (1983; 2002) that the renovated ship is identical to the original and that the thieves' claim is false. His reasoning runs as follows: As the parts of the renovated ship are being removed they do not yet form a part of any ship. At any point in the course of the reconstruction, they are not part of B. At the end of the process, the thieves claim that the reconstructed ship A is identical with original B. However, it is

part of the thieves' contention that it is identical to some B which did not undergo renovation. The Ship of Theseus might not have undergone a renovation, but in the actual world it did. This means that the reconstructed ship which would have been composed of those parts had renovation not occurred is, in fact identical with a different ship from the one that actually underwent renovation namely B, our The Ship of Theseus. Therefore the reconstructed ship is not actually identical with the Ship of Theseus.

The difference between Lowe's solution and the others considered above is the degree to which he takes seriously the reality of the original ship. Specifically, for Lowe, the individuality of the ship is understood in terms of its modal properties. By contrast, when one considers the problem from an epistemic perspective one loses access to this criterion. So, rather than focusing on logically consistent alternative systems of identification, Lowe's solution assumes something about the modal properties of the original, the renovated ship and the thieves' ship. His claim that the reconstructed ship is not actually identical with the Ship of Theseus rests on the comparison of these properties. Of course, the meaningfulness of an appeal to the modal properties of the artifacts would be entirely undermined if artifacts are not real. However, if artifacts are not real, then the Ship of Theseus problem is not a *real* problem to begin with. If individual artifacts are real, then they will have modal properties which can be distinguished along the lines Lowe describes.

4. Animals and artifacts

We might wonder whether that solution applies cleanly to problem cases of identity conditions for organisms. If the modal properties of artifacts and animals are the same, then the solution is directly applicable. The conditions governing the identity of organisms are worth considering in detail.

Let's consider Lowe's analysis in the case of the creation of new organisms. A similar situation to the one depicted in the Ship of Theseus problem is the case of asexual reproduction by fission. Many organisms reproduce by a process of dividing into two. As with the ship of Theseus, the trouble with binary fission is that there is an increase from one to two organisms and we might wonder which of the two has a superior claim on being identical with the original. Philosophers of biology have considered questions of identity for cases of asexual reproduction in some detail. In his discussion of reproduction in hydra, Sober asks: "If Mom splits exactly in half and each half develops into a complete hydra, which half is the continuation of Mom?" (1993, 152) He concludes that the natural decision is to identify her with neither. In the case of binary fission, he claims, the old organism is destroyed, and a new pair of organisms comes into being. Lowe agrees with this conclusion arguing that symmetry considerations make it impossible in principle to identify one of the fission products with the original in a non-arbitrary way. (2002, 35-36) In cases of symmetrical fission such as when a single amoeba divides into two Lowe and Sober agree that the original object ceases to exist and that fission gives rise to two new objects. Note that Lowe reaches this conclusion insofar as the case of the ships involved asymmetrical division whereas the amoeba cases are supposed to be symmetrical.

When philosophers discuss reproduction via symmetrical fission, amoeba and hydra are inappropriate examples. It would be more biologically accurate to point to prokaryotic binary fission as an example for symmetrical fission, however even prokaryotic fission would fail to embody precisely the kind of scenario that philosophers have in mind. (Margulis and Sagan 1986; 2002) In this case, noting the inadequacy of the examples that philosophers deploy in thought experiments is not mere nit-picking. Rather, it is important to recognize that symmetrical fission serves as a limit case in a philosophical thought experiments and that instances of it will not be encountered under ordinary circumstances. Biological fission is asymmetrical and even the humble amoeba turns out to be a fair bit more complicated than usually discussed.[4] The mismatch between the actual cases and the thought experiment should remind us that biological individuality (unlike the question of identity) is not a simple or purely conceptual matter. Eukaryotes like amoeba have a nucleus, organelles, structural division via membranes etc. In eukaryotic species like the amoeba, cell division is a complicated process whose details would shed light on the question of the identity of the amoeba. Admittedly, it is difficult to imagine a non-philosophical context in which one might actually be interested in the individuality of a particular amoeba.

Debates concerning symmetrical fission are not directed towards the actual cases of fission in nature. Instead, these discussions are meant to address general features of the metaphysics of identity. However, until we take the natures of the individuals in

[4] Andrew Reynolds (2008) describes the history of the role of the amoeba in the philosophy of biology. From the nineteenth century onwards, it was able to play the role of a kind of conceptual placeholder for philosophical notions of primitiveness and fundamentality. In part, he argues that "It was able to do this because ''the amoeba'' denotes not a particular organism, but a general type of behaviour common to the cells of a range of protozoa, simple plants and higher animals." (2008, 307) Amoeba have played a similar role in modern debates concerning fission and identity. The actual process of cell division in amoeba, as described in, for example Madigan et al (2000), does not match the ideal of symmetrical fission which we find in philosophical reflections on identity and individuality.

question into account, there will be a broad set of questions which are not decidable. As we saw above, the Lewisian strategy for fission cases is to claim that both entities had overlapped for a while in the prior region of space-time. The solution becomes less plausible when we consider that we are committed to the existence of countless overlapping individuals in the original entity. The trouble with Lewis' ontological nonchalance is that there is no non-arbitrary way to decide whether or not an infinite number of entities are packed into the pre-fission world-worm for our amoeba. The fact of the matter will depend on the ultimate character of the universe as a whole, as to whether the universe is temporally spatio-temporally finite, whether a modal realist metaphysics is true, whether we're presentists etc. In the meantime, for Lewis, our judgments concerning individuation are relative matters. As we saw above, judgments that A and B are identical are always restricted to "respects of comparison". As such, rather than addressing specific ontological questions, on Lewis' account, all questions of individuation are addressed in terms of our judgments.

In response to this line of criticism, the Lewisian might respond by objecting to the very notion that there exists a non-epistemic problem of identity or individuality for organisms because:

a. the organism never gets properly identified in the first place

or

b. there is actually nothing being individuated.

The first criticism (a) relates to our epistemic properties, insofar as it relates to our capacity to identify while (b) assumes a metaphysical fact; that any putative individual which we might pick out, doesn't really exist, whether because it is causally preempted by its constituents or for some other reason. Limitations or sloppiness in our practices of identification are irrelevant to the question of the individuation of the object and pointing to such limitations does not run counter to whether there is a productive line of investigation with respect to the metaphysical question of identity. Any force which the objection might have in this context would derive from tacit (or, in the case of (b), explicit) reliance on a metaphysical claim. In themselves, the vagueness of our ascriptions, the sloppiness of our identifications and the limitations of our epistemic powers are not directly relevant to the challenge of understanding individuation.

Returning to Lowe's solution to the Ship of Theseus problem, as discussed above, he argues for the identity of the renovated and the original ship on the basis of the ship's modal properties. Do the same kinds of considerations apply to cases of asymmetrical binary fusion in organisms? The difference between the two cases involves the status of the original parts. In the kinds of cases we might actually encounter we find one organism and some set of parts drawn from the environment which will be assembled into the second organism. When we consider cases of asymmetrical fission in biology, our options are the following:

(a) the original organism persists through this kind of process in the same way that the renovated ship permits in the Ship of Theseus cases

(b) the initial organism dies and we have two new organisms in its place

Lowe and Sober favor the second alternative in their discussions of reproduction by fission, but of course they were addressing cases of symmetrical fission, where the choice of one over the other was, by stipulation, unavoidably arbitrary. As discussed above, real fission is asymmetrical.

If we opt for the first option, then the odd consequence is that we are committed to the possible existence of a very old amoeba.[5] One might be ready to accept the possible existence of such a creature, after all, there are cases of living bacteria which are reported to be as old as half a million years. While age might not be a disqualifier, there are other reasons to doubt that the amoeba can continue as an individual through the process of fission.

The individual amoeba is a set of interdependent functions. These functions depend, in part on the activity of the organism's DNA. If we identify the organism via the structural character of its DNA, then we have a relatively clear condition which we can employ in determination of its existence conditions qua individual. During mitosis, DNA synthesis in the cell cycle (specifically in the S phase of the cell cycle) consists of a series of steps involving enzymes which unwind a portion of the DNA molecule –these enzymes work by breaking the hydrogen bonds between paired nucleotides and separating the two strands of the molecule. New nucleotides are added to each strand by another set of enzymes. DNA polymerase acts such that new nucleotides are added from opposite ends of the DNA molecules two strands. The two strands of the DNA molecule

[5] Only possible existence since the old amoeba in question might have been destroyed in some previous generation while her daughters lived on.

are therefore undergoing distinct processes during mitosis and the original structure which characterized the organism is no longer present. So, if we identify the individual organism with the functionally interdependent system of its parts and if the ordinary activities of the amoeba are dependent on the DNA, then during mitosis, amoebas die or perhaps it is better to say, amoebas are destroyed.[6]

Reproduction is one of the clearest characteristics of living things, but strictly speaking, it isn't necessary for the individual organism itself. Reproduction can tax the resources of parents in dramatic ways. In cases of reproduction by fission, the process of mitosis subordinates the functional interdependence of the individual amoeba to the requirements of reproduction.

Biological fission is unlike the case of the Ship of Theseus insofar as fission involves an interval in which the definitive functional characteristics of the individual are no longer present. By contrast, the ship remains identical with itself insofar as its modal persistence properties are unchanged and insofar as it remains the kind of individual it is. It is the kind of individual it is by virtue of the creator(s) intentions in the production of the ship. Even if the ship were to spring a leak and sink to the bottom of the sea, it would not cease being a ship, rather, it would be a defective ship. By contrast, an organism would be dead, if its functional interdependence were to break down. A dead organism is not merely defective, it is, instead, no longer identical with itself.

In multicellular organisms, the system of functional interdependence is such that the destruction of a single cell is not a threat to its individuality. Of course, the

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[6] Some have argued that the notion of death for an amoeba makes no sense here. For example, Lyn Margulis (1986) denies that it makes any sense to talk about amoeba dying. For Margulis, sex and death are connected. "Death," she writes, "was the first sexually transmitted disease." Notice here that death is being distinguished from destruction. If I pour bleach on the amoeba I destroy it, but she would deny that it dies.

destruction of cells or structures of certain types or beyond a certain threshold would be fatal. However, there is no way to know what that number would be without understanding the functional interdependence of the parts of the organism. The character of this interdependence varies with the kind of organism in question. As Sober notes, cutting 20% off an ivy plant is unlikely to kill it, whereas cutting 20% off a tiger almost certainly would. In the case of the individual amoeba, fission involves the unraveling of the functional interdependence that is constitutive of its individuality.

5. Genetically engineered animals

Given that artifacts are what they are by virtue of the intentions of their designer, does this mean that genetically engineered animals will have different persistence conditions than their wild cousins? So for example, would the modal properties of a genetically modified amoeba be like those of the Ship of Theseus? I will argue that even in the case of genetically engineered animals, the distinction between artifacts and animals can be maintained. Genetically engineered animals, qua individuals, are still animals.

We can begin with cases where it is easy to distinguish those features of the animal which are an artifact, from the individual itself. So, for example, a device, say a pacemaker might be introduced into a person in order for her heart to continue beating normally. This pacemaker has become a vital part of the functional interdependence that constitutes her individuality. However, notice that the pacemaker, does not depend for its continued existence on the person's other functions. Obviously, when she dies, the pacemaker will still be a pacemaker and could possibly even be reused in another body.

Genetic engineering is different. Here, a genetically modified organism has been manipulated at the genetic level in order to allow for the selection of some preferred set of functions. If a tomato plant is modified such that its fruit is pink rather than red, the genetic basis of this modification is unlike the pacemaker insofar as the genetic basis of the modification becomes a genuinely dependent part of the functional interdependence that constitutes the organism's individuality. So, would it be correct to consider the genetically modified tomato plant a tool? Clearly, there are consistent ways of seeing organisms as tools. One might want to use bamboo plants as a fence or zebras as meat producing machines. In such cases, one has selected a specific function that the bamboo plants or the zebra can instantiate. Producing muscle and fat, is, of course, part of the zebra's ordinary set of interdependent properties. In a sense, our zebra can therefore instantiate the function of being a meat machine. But is some specific zebra, say Harry the zebra, a meat machine? Yes, Harry is a meat machine but he is as much a meat machine as a crab is an ashtray. A crab's shell can serve as an ashtray or maybe as a Frisbee. We can imagine a large number of functions which a specific organism might serve or instantiate which are instantiated in parallel with the functional interdependence among its parts that supports the organism's individuality. The crab has not stopped being a crab, nor has it lost its individuality, because a vulgar man is seeing how well it might serve as an ashtray.

The identity of tools is related directly to the intentions of their producers. In some cases, found objects, like shells, sticks or stars, can be used as tools insofar as they instantiate some preferred functional properties. Returning to our pink tomatoes, unlike the tomato plant itself, the artifact is multiply instantiated and can outlive the individual

tomato plants. If it has been genetically modified to produce pink fruit, our tomato plant is instantiating a function which, even though it might be part of the interdependent functions which constitute its individuality, has the same standing as the zebra's property of instantiating the function of being a meat machine or the crab's property of serving as an ashtray. The persistence conditions of a genetically modified organism depend on the conditions that underlie its individuality. These conditions are distinguishable from the organism's capacity to instantiate some preferred function.

Finally, there is the challenge of artificial organisms. In these cases, let's imagine all aspects of the organism are engineered and that it is completely artificial, along the lines proposed by Mark Bedau and his colleagues. (forthcoming) Notice that the previous analysis did not rest on the difference between naturalness and artificiality. The factor that determines the persistence condition of the organism is the functional interdependence or the parts of the organism and not on the origins of that interdependence. Thus, an individual artificial organism can be considered just as much an individual as one with no artificial ingredients.

In conclusion, we have seen that our intuitions concerning the difference between organisms and artifacts can be understood as picking out a difference with respect to the kind of individuality that they possess. This paper argues that this difference is easier to appreciate once we distinguish identity from individuality.

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