The Problems of Biological Design

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I. Selection and Design

Here is one way that philosophers and biologists sometimes speak of Darwin's explanatory innovation: 'Eyes, organs of echolocation, camouflage and the like are all wonderful instances of contrivance, of complex adaptation, of good design. Paley and the other natural theologians sought to explain this good design by appeal to an intelligent designer. Darwin, on the other hand, offers us a superior explanation for the appearance of this same property: Darwin shows us that we can explain good design through the action of selection. Indeed, selection is the only process that can explain good design in nature. And that is why evolutionary biologists can continue to use a version of the argument from design called the *argument from biological design*: when we see an instance of good design in nature, we should infer not the guiding hand of God, but the hand of selection at work.'

This way of talking about design and selection raises three interrelated problems. They are the problem of *continuity*, the problem of *monopoly*, and the problem of *inference*. The problem of continuity arises when we ask whether modern evolutionary biology and natural theology both seek to explain the same phenomena. What does this question mean? A very weak reading of continuity is easy to come by, and this reading will yield an affirmative answer to our question. It is true that some of the specific traits that are the objects of natural selection explanations—most obviously traits like eyes and wings—are the same as those that Paley was interested in. But can we go any further than this in uniting the two schools of thought? Is there some sense in which both aim at an understanding of 'good design'? One might think the answer must be no, on the grounds that Darwin shows that there is no design in nature to be explained. Yet biologists sometimes link the explanada of their theory quite explicitly to those of Paley. John Maynard Smith writes that 'the main task of any theory of evolution is to explain adaptive complexity, that is, to explain the same set of facts that Paley used as evidence of a creator'.[1] In claims

[1] J. Maynard Smith, 'The Status of Neo-Darwinism', *Theoretical Biology*, C. H. Waddington (ed.) (Edinburgh: University Press, 1969).

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such as this it seems that 'adaptive complexity' is supposed to mean roughly the same thing as 'good design'; the different terms are chosen only to avoid the connotation of 'good design' that the property is a product of an intelligent designer. Richard Dawkins is even more explicit than Maynard Smith in his alliance with natural theology. Natural selection is the 'Blind Watchmaker': it has no foresight, but it still makes watches—i.e. well-designed entities.[2] Dawkins is quite open about his regard for Paley:

> I suppose people like me might be labelled neo-Paleyists, or perhaps 'transformed Paleyists'. We concur with Paley that adaptive complexity demands a very special kind of explanation: either a Designer, as Paley taught, or something such as natural selection that does the job of a designer.[3]

This brings us to the problem of monopoly. Dawkins does not merely note the phenomena of good design in nature, he also argues that selection is the only process that could explain their appearance.[4] There are apparent counter-examples to this claim. One might think that 'self-organization' can explain some instances of good design, or one might prefer less exotic examples such as the simple physical processes that produce the regular structures of crystals.[5] The obvious counter-argument for Dawkins to fall back on (also tentatively suggested by Sober[6]) is to say that such things as self-organization or crystal formation produce instances of regularity, order, or pattern, but not good design. The problem of monopoly is to give an account of what good design is, and how it differs from order, without thereby making the claim of monopoly vacuous. If 'well-designed' ends up being defined as 'produced by natural selection', then of course selection is the only property that can explain good design, but this will hardly be an important claim.

The problem of inference is to clarify and evaluate the argument from biological design; that is, the argument that takes as a premise the fact that some trait is well designed, and uses this as a basis for concluding that the trait was shaped by natural selection. The

[2] R. Dawkins, *The Blind Watchmaker* (London: Penguin, 1986).

[3] R. Dawkins, 'Universal Darwinism', *The Philosophy of Biology*, D. Hull and M. Ruse (eds.) (Oxford: Oxford University Press, 1998), p. 16.

[4] Ibid., 15–16.

[5] Self-organization is much discussed in S. Kauffman, *At Home in the Universe* (London: Penguin, 1996).

[6] E. Sober, 'Six Sayings About Adaptationism', *The Philosophy of Biology*, D. Hull and M. Ruse (eds.) (Oxford: Oxford University Press, 1998), p. 74.

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natural theologians would argue from the proposition that a trait T is well designed for an effect E to the proposition that T was designed for E by God. Contemporary evolutionists appear to keep this inference almost entirely intact. They argue from the proposition that T is well designed for E to the proposition that T was designed for E by natural selection. A very clear statement of this view appears in work by Pinker and Bloom, who say that 'evolutionary theory offers clear criteria for when a trait should be attributed to natural selection: complex design for some function, and the absence of alternative processes capable of explaining such complexity'.[7] The problem of inference is once again to explain what 'complex design' means here, and to see how the biological argument from design holds up in the light of the account of good design we arrive at.[8]

II. Defining Design

It is easiest if we begin with the problem of inference; I will make some comments about the problems of continuity and monopoly in the final section of the paper. Proponents of the argument from biological design think that there is a property of good design, which indicates the action of selection when it is present in organic nature. They agree that sometimes good design really is explained by intelligence—namely when it is manifested by things like watches and computers. In order to get to an understanding of the nature of design and design arguments I want to look first at the ways in which we infer the presence of intelligent designers from the makeup of objects. Is there a property of 'good design' that tells us when an intelligent agent has been at work? Let us consider this definition of good design:

> **DI**: T is well designed for some effect E iff in the right context T would produce E better than a range of alternatives $T_1 ... T_N$.

DI makes good design an intrinsic property because having this property does not depend logically on the context T is in, nor on T's history. I introduced a range of alternatives into this definition to

[7] S. Pinker and Paul Bloom, 'Natural Language and Natural Selection', *Behavioral and Brain Sciences* **13** (1990), 707.

[8] A very useful paper that discusses this inference in far more detail, and gives many more examples of its use and defence, is G. Lauder, 'The Argument from Design', *Adaptation*, M. Rose and G. Lauder (eds.) (San Diego: Academic Press, 1996).

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give some sense to the idea that T is good at E-ing. This just means that T is better at E-ing than these alternatives. One might rightly worry which alternatives we are allowed to consider. I want to set this question aside, because as it stands DI isn't much use to us however we might spell this out.

If an object is well designed for some effect E in the sense of DI, then should we conclude that some intelligent agent probably designed it for E? No. If we follow this pattern of argument we need only find an effect of an object that is unique to it, and we will conclude that it is well designed for that effect. So pick any large rubbish tip you like. That tip has a very specific effect; it looks and smells a certain way. It is much better configured to look and smell that way than any other rubbish tip—had its organization been a little different then it would have looked different, its shape would have been different, it would have smelled a little different. The rubbish tip is well designed in the sense of DI for looking and smelling the way it does, but this is not evidence for the tip having been produced by intelligence. The problem here is not that intelligent design is a poor explanation in comparison to natural selection—that the tip is well-designed for appearing the way it does is evidence neither for the action of intelligence, nor for the action of selection.

Perhaps we can revise our version of the design argument a little, but keep a central place for DI's account of good design. We might think that some configurations of matter do not require an intelligent design process to explain them, because their presence is made very likely, and hence explained, by the action of some other, simpler, set of processes. A stone is good at weighing down papers, but the stone's capacity to do this can be explained quite simply without recourse to intelligent intervention. But, the intuition goes, some systems rely on such delicate arrangement for the performance of their effects, that we cannot assume that natural processes could have produced those effects without guidance.

Suppose, then, we revise the design argument like this. If an object is well designed for some effect in the sense of DI, and if the configuration required for that effect would be unlikely to arise in the absence of a process of intelligent design, then intelligent design is probably responsible for its configuration. As is probably obvious to most readers, this does not help with the problem at hand, for even this revised version tells us to infer that an intelligent design process produced the rubbish tip. There are many apparently equally likely ways the rubbish tip could have turned out. On the assumption that the tip is not the product of an intelligent agent adjusting it to have just the configuration it does, then its having

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just that configuration is a highly unlikely outcome. Its configuration is far better than alternatives at producing the effect of looking just that way to perceivers. So the tip was probably designed by an intelligent agent to look that just that way to perceivers.

The creationist Michael Behe slips up badly here in his characterization of the argument from design. He writes that:

> For discrete physical systems—if there is not a gradual route to their production—design is evident when a number of separate, interacting components are ordered in such a way as to accomplish a function beyond the individual components. The greater the specificity of the interacting components required to produce the function, the greater is our confidence in the conclusion of design.[9]

This makes the inference to intelligent design vacuous. Almost any system has some effect or another that depends on its internal components being organized just so, the rubbish tip's appearance to human observers included. We can even assume, in line with Behe's exclusion from this inference schema of systems for which gradual alteration can explain their effects, that the rubbish tip's look and smell are quite sensitive to changes in its internal configuration, so that slight differences to how it is organised make a big difference to how it looks and smells. We should not be at all confident that the rubbish tip was designed by an intelligent agent to look and smell just the way it does, but Behe's recipe tells us we should very confident of this. That is why Behe's version of the design inference should be rejected—not just when using it to make inferences about divine design and the natural world, but when we consider whether objects are designed by humans, too.

It is possible that Behe thinks we really do have decent evidence, in virtue of the rubbish tip's unlikely configuration, for the claim that someone designed it that way. Behe thinks the hypothesis that Italy was designed by someone who is a fan of boot-shaped countries should not be ruled out too quickly. He writes:

> Italy may have been intentionally designed to look like a boot, but maybe not. There is not enough data to reach a confident conclusion.[10]

This extraordinary claim could only come from someone who rules out sources of data external to the object itself in evaluating

[9] M. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: Simon and Schuster, 1996), 194.

[10] Ibid., 198.

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whether the object has been intelligently designed for one of its effects. Yet these data are crucial. Here lies the defect of trying to use a property like good design in the sense of DI as the sole basis for inferring intelligent agency. Establishing that something is well designed in this sense does not show that we should invoke either intelligence or selection to explain its makeup. Of course it is true to say that someone very powerful *could* have designed Italy to look like a boot, and she may have been more modest than the character Slartibartfast from Douglas Adams' *Hitchhikers' Guide to the Galaxy*, whose name is left carved in the fjords of Norway. But it is also true that someone *could* have designed a rubbish tip to look just like that. That fact about a remote metaphysical possibility isn't enough to shake our confidence in the lack of intelligent agency overseeing the building of rubbish tips, and the mere possibility that Italy was intelligently designed shouldn't shake our confidence in the lack of intelligence overseeing Italy either. The moral of the failure of DI as a sole ground for inferences to intelligent design is that it shows the importance of extrinsic information—facts that relate to things other than an object's structure and capacities—for assessing whether an object has been intelligently designed. Such facts include, in the case of inferences to intelligent design, information about the goals and powers of potential designers. No actual individual, it seems, has any interest either in making a rubbish tip look and smell just like that, nor in shaping Italy to look like a boot. True enough, some modern art really is structurally indistinguishable from undesigned rubbish, but we can tell that this art was designed by an intelligent agent all the same by drawing on rich, extrinsic, contextual data about the places where the work is found, the conventions for displaying artworks, facts about recent trends in the art world and so forth. Design inferences require information about far more than the structure and capacities of an object if they are to be reliable.

III. Cosmic Design

These observations about design inferences in the case of rubbish tips and artworks undermine cosmic intelligent design arguments that seek to attribute the means/ends organization of the universe to an intelligent designer. When we recognize structures as intelligently designed, it is (in part) in virtue of our knowledge of the goals and powers of intelligent agents. It is in part because we know that people like to eat food and are able to make medium sized

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tools that we can infer that objects that would be very helpful in catching and killing edible animals were probably intelligently designed for that effect. That means that if we want to infer the existence of a cosmic designer from the structure of the universe, we would need evidence of the cosmic designer's goals and powers.[11] Yet those who think they can infer the existence of an intelligent designer from, say, the 'fine-tuning' of certain universal constants, rarely think they have evidence of the designer's goals and powers, except for the evidence provided by the fine-tuning of those constants themselves. In other words, the fact that the universe is good at producing life is taken by itself to be evidence of a designer who is keen on a life-bearing universe, who has the power to make such a thing, and who has built something to meet her goal. But inferring goals, powers and a design process as an explanatory package-deal is analogous to inferring merely from the existence of a rubbish tip the existence of a designer with the goal of making a tip with just that makeup, a designer with the power to produce such a tip, and the process of design that explains how the tip gets to have just that makeup. Since this is not how we make inferences about the design history of artefacts, analogy cannot be used to show that our practice of inferring that a watch is intelligently designed commits us to inferring also that the universe is intelligently designed on the basis of the suitability of its universal constants to the existence of stars, organic life, or whatever.[12]

In general, we are exceptionally cautious about making package-deal design inferences, even when we have evidence that an agent will benefit from an apparently unlikely outcome. National Lottery winners have a clear interest in what appears to be an unlikely result. The hypothesis that Fred won the National Lottery fair and square makes Fred's winning exceptionally unlikely, and the same goes for every lottery winner. So should we infer to an apparently better explanation—namely that every lottery is fixed, and therefore each winner was always very likely to win after all? No: sometimes very unlikely things happen, even unlikely things that are in the interests of some agent. Yet we are far more confident of claims about lottery fixing if we have information that Fred has a brother who works the lottery machine. Once again, we insist on rich

[11] I owe this point to E. Sober, 'The Design Argument', *The Blackwell Guide to the Philosophy of Religion*, W. Mann (ed.) (Oxford: Blackwell, forthcoming).

[12] Some useful papers on cosmic design arguments are collected in *God and Design: The Teleological Argument and Modern Science*, N. A. Manson (ed.) (London: Routledge, 2003).

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background information to bolster our inferences; we do not trust package-deal operators.

IV. The Biological Argument from Design

It is now time to assess the biological argument from design directly. Pinker and Bloom's criterion of 'complex design for some function and the absence of alternative processes capable of explaining such complexity' as a mark of the hand of natural selection threatens to make the biological argument from design vacuous. For it seems at first glance that they must mean one of two things when they write of 'complex design for some function'. If they wish to allude to the dominant account of functions, then the argument from function to selection appears to become trivial. Many philosophers these days defend what is called the 'Selected Effects' account of functions, which tells us that claims about functions are claims about selection histories.[13] If this account is the right one, then it is a conceptual truth that traits that have E as a function were selected for E—the function claim is not evidence for the selection history, rather, they are logically equivalent propositions.[14]

Perhaps we should try a second reading of Pinker and Bloom's claim. Suppose that when they write of 'complex design for some function' they mean only that the trait is good at producing some effect. This reading makes their criterion for the hand of selection stumble in just the same way that Behe's criterion for intelligent design stumbles. For this version of the argument from biological design implies that once we find some effect that (i) a trait would be particularly good at, and which (ii) relies on the trait being in a state that would be very unlikely to arise in the absence of selection for that effect, then we should conclude that the trait has probably been shaped by selection for that effect. But then we need only find some unlikely configuration of matter (organic matter this time), find some effect it has that relies on it being organised just that way, and we will conclude that it was probably shaped by selection to be like

[13] This is not the place for comprehensive references to the Selected Effects account. Many of the most important papers are collected in *Nature's Purposes: Analyses of Function and Design in Biology*, C. Allen, M. Bekoff and G. Lauder (eds.) (Cambridge, MA: MIT Press, 1998).

[14] For an evaluation of the Selected Effects account see chapter five of T. Lewens, *Organisms and Artifacts: Design in Nature and Elsewhere* (Cambridge, MA: MIT Press, 2004).

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that. So because the pigmentation of the Friesian cow is well designed for the effect of camouflaging these cows in a Gateway computer factory, we should conclude that the Friesian's pigmentation was probably shaped by selection for this camouflaging effect. After all, it is surely unlikely that pigmentation would appear with just those colours in just that orientation in the absence of selection for that pattern, and the excellence of the pigmentation in producing this effect therefore seems to demand a selective explanation.

Thankfully we needn't abandon design arguments in biology, because they do not work in quite the way one might take Pinker and Bloom to imply. Just like arguments for intelligent design, they are also heavily constrained by contextual evidence, and rightly so. The first thing we need to note here is that the argument from biological design is typically used to determine whether a trait has been 'shaped' by selection, not merely whether the trait has increased its frequency in virtue of some effect.[15] That is, the argument is used to determine whether the trait is a product of a process that acts over time to build structures that become progressively better at meeting demands of the local environment. It is not a trivial truth, even on the dominant account of functions, that if something has a function it achieves through some complex arrangement of parts, then it has probably been shaped by selection for that function.

One important set of information that helps determine whether a trait is indeed the product of selective shaping for some effect E is information that tells us not just whether the trait in question would have been good at producing E, but whether E-ing would have contributed to fitness in the organism's past. After all, the trait might be excellent at E-ing, but E-ing may be completely irrelevant to the organism's prospects for survival. That is why the excellence of Friesian cow pigmentation in providing camouflage in a computer factory is not evidence of selection for this effect, for this effect was of no relevance to the cows' survival. To determine whether some effect of a trait was fitness enhancing in the organism's past, we need to know facts extrinsic to the trait itself, such as whether other traits could have interacted with the trait in question in the appropriate way, and whether the organism's environment was such that E-ing would have been valuable.

Richard Dawkins finds an interesting way of saying something right about these kinds of design arguments when he gives this informal definition of good design:

[15] I discuss this notion of 'shaping' in more in op. cit., note 14, chapter 2.

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> We may say that a living body or organ is well designed if it has attributes that an intelligent and knowledgeable engineer might have built in order to achieve *some sensible purpose*, such as flying, swimming, seeing, eating, reproducing, or more generally promoting the survival and reproduction of the organism's genes [my italics].[16]

Dawkins will go on to say that good design in this sense can only be explained by natural selection, with the result that good design is diagnostic of the action of selection. The specification of a 'sensible' purpose sounds strange here. Why on earth would an intelligent and knowledgeable engineer think that building a machine for eating, or for reproducing is a sensible endeavour? She probably wouldn't, but the demand that the effects of a trait must be sensible is really just a roundabout way of saying that they must make some contribution to survival and reproduction. Almost anything could make such a contribution, given the right environment. So Dawkins had better not be licensing an inference of the form 'it is possible that T augmented fitness by E-ing, and T is very well suited to E-ing, so T was probably shaped by selection for E-ing'. That pattern of inference would enable us to conclude that cowhides probably have the pigmentation they do because they have afforded camouflage in computer factories. Let us read Dawkins charitably as drawing attention to our need for information about what the past environments of traits have been like if we are to say what effects are sensible, hence what a trait has been shaped for. This reminds us that we must also handle with care Dennett's perfectly legitimate appeal to the good design of *Archaeopteryx*: 'An analysis of the claw curvature, supplemented by aerodynamic analysis of wing-structure, makes it quite plain that the creature was well-designed for flight'.[17] We must not suppose that this claim instantiates a generally reliable inference schema from 'T would have been excellent at E-ing' to 'T was probably shaped by selection for E-ing'. There is nothing wrong with Dennett's claim about *Archaeopteryx*, but there is no such reliable design argument, either.

V. Design Problems

My reconstruction of the argument from biological design allows us to see some of its limits quite clearly. When a trait augments the

[16] Op. cit., note 2, 21.

[17] D. C. Dennett, *Darwin's Dangerous Idea* (New York: Norton, 1995), 233.

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fitness of its bearer, and when this relies on a very specific set of relations between its parts, it is often the case that the best explanation for this state of affairs is that the trait has been shaped gradually by selection to acquire that structure. There are, however, alternative explanations. Perhaps the organism/environment relation that results in the trait in question augmenting fitness is produced not by gradual alteration of the trait to match its environment, but instead by gradual migration of the species into an environment in which the pre-existing trait enhances fitness. This is a selective explanation of sorts, because one can suppose that the relational trait of *being in a better habitat* is one that increases its frequency in a population of organisms in different habitats. But clearly the metaphor of selection as craftsman—the metaphor encouraged by thinking of selection as a stand-in for the natural theologians' divine artificer—is inappropriate here. Selection does not shape these organisms to match their environments; rather, the environment changes to match the organisms.

This means that talk of 'good design' in contemporary biology may not be entirely innocent. In the realm of artefacts, good design is typically explained by good designers. Transferring this principle to the organic world, Dawkins implies that good design is also explained by a good designer, albeit a blind one. When selection is characterised in this way as a craftsman—as the 'Blind Watchmaker'—we are liable to overlook explanations for adaptation that turn to migration, rather than mutation. Migration explanations are selection explanations, but not explanations that have obvious analogues in intelligent design processes. Craftsmen shape artefacts to fit design problems; they rarely seek design problems to fit to artefacts. But selection is not constrained in this way, in spite of the watchmaker label that talk of biological design, and the consequent projection of a biological designer, invite.

VI. Continuity, Inference and Monopoly

It is time to bring together some answers to the three problems of biological design. Here I will tackle continuity first, then inference, then monopoly. In sections two, three and four we saw that there is no intrinsic property of 'good design' that is reliably diagnostic of either intelligent agency or of natural selection as the shaper of material form. This means that if any property of 'good design' is diagnostic of such historical processes, the property in question

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would have to be characterized extrinsically. This observation makes things difficult for the claim of continuity. That claim seems to demand that one single property of 'good design' shows us reliably that either intelligence, or selection, is historically responsible for some aspect of form. Only if that is true can we say that evolutionary theory focuses on the same class of phenomena as natural theology—namely, the well designed traits. Yet it is hard to see how one single property of good design can be possessed by both organisms and artefacts, if that property must be characterized extrinsically.

For artefacts, the property of being well designed that indicates an intelligent design history must be something like the property of being well suited to the needs or desires of users. On the face of it, this cannot be what biologists are talking about when they speak of well designed traits, for biological traits, one might think, rarely have genuine users, and certainly not users with desires. Users, it seems, are agents, and the well-designed sexual organs of plants (for example) do not derive their good design from the satisfaction of any agent's needs. For organisms, when we talk of a trait being 'well designed' we can only mean something like 'augmenting fitness in actual environments'. Such a reading of 'well designed' meshes with what Dawkins and Pinker say about the argument from biological design itself. So it is hard to see how intelligent design and natural selection can be said to explain the same property, even though the properties each process is believed to explain are given the same name.

It is nonetheless possible to explain the appeal of the continuity claim, for in a variety of metaphorical senses we can assert that fitness-augmenting traits answer needs or desires. On the one hand, there is a metaphorical sense in which one might say that an organism's environment lays down desiderata for how the organism should be constructed. Biologists of various kinds regularly refer to environmental problems in this sense. Alternatively, one might think loosely of an individual organism, or even of some type of gene, as the user or manipulator of organic traits, while thinking metaphorically of the maximization of fitness as the primary goal or desire of organisms or genes. In these ways, both the natural theological and the evolutionary conceptions of being 'well designed' are united under the general concept of a structure in virtue of which needs or desires are efficiently satisfied.

Second, the problem of inference. Is there a good inference from 'X is well designed for E' to 'X is shaped by selection for E'? As we saw, the answer is 'yes', but with qualifications. Sometimes having

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some fitness-augmenting effect indicates selective shaping, but not always, and it is a fault of phrasing this biological inference in the language of design that we are liable to overlook explanations for the existence of fitness-augmenting traits that look to migration, rather than the gradual modification of a trait in the face of a largely stable environment.

Third, the problem of monopoly. Does selection provide the only legitimate explanation of good design? It turns out that there is no pressing need for biology to answer this question in the affirmative. When we defended the argument from biological design we did so by restricting our understanding of 'well designed trait' to 'trait that augments fitness in actual environments'. The justified use of specific instances of the biological argument from design does not require that selection has a monopoly on the explanation of 'good design', where 'good design' is understood in an overarching sense; it requires only that selective shaping is typically the best explanation for the existence of fitness-enhancing traits. The battle against creationism also requires no defence of the overarching monopoly claim: that battle requires at the most that we show that there are no actual phenomena whose existence is better explained by the action of a divine creator than it is by non-intelligent processes.[18]

Not only does biology require no defence of the claim that selection is the only process that can explain good design understood in a general sense, it may be a mistake to try to formulate such a defence. At the beginning of the paper we considered bolstering the claim of monopoly by distinguishing between design and order. We briefly mentioned the argument that although processes other than selection might explain order, they cannot explain design. The attempt to distinguish design in general from order in general is made more difficult by the extrinsic nature of the property of being well designed. When discussing 'good design' in the context of artefacts we saw that any configuration of matter could be indicative of an intelligent design process, just so long as we suspect there might be agents who have interests in bringing such configurations about, and who have the ability to do so. Intelligent agents sometimes design chaotic configurations of rubbish; sometimes ordered patterns are designed by intelligent agents, too. Conversely, unless we think that agents exist with the right goals and powers, we need not recognize any state of affairs as 'well designed'. So, in the domain of artefacts, the

[18] Here I am expanding on what I take to be Sober's view, op. cit., note 6, 75.

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contrast between ordered patterns and designed patterns also demands that we specify some set of needs or desires of users by which to reckon design good or bad. For organisms, the distinction will be drawn instead in terms of whether the trait in question is merely regular, or whether it also augments fitness. The lesson here is that one cannot draw a generic distinction between order and design; we can only draw local distinctions between order and design within whichever domain (organic, technical) we are considering.

The extrinsic nature of the property of being 'well-designed' thus makes it difficult to spell out what that property is in general terms, such that we might plausibly claim that in all domains good design is explicable only by selection. Within the domain of biology we can assert a restricted monopoly claim, namely that whenever some trait contributes to fitness in an actual environment, shaping by selection is the explanation. If we want to generalize this assertion, and use it as a basis for the claim that selection explains good design in all domains, then we would need to understand fitness as the kind of property that need not be restricted in its instantiation to the biological realm. Indeed, one might try to unify the concepts of good organic design and good technical design through an appeal to some kind of evolutionary model of creativity.[19] That project is beyond the scope of this essay.[20] But what are the prospects for this kind of monopoly claim when we consider the domain of biology alone? Fitness-enhancing traits need not always be explained by selection acting on gradual variation. To take one contentious example, macromutation may sometimes produce fitness-enhancing traits, too. So selective 'shaping' is not the sole explanation for how such traits come to be. One could reply to this by saying that fitness-enhancing traits produced by macromutation are not 'well-designed', for on those rare occasions when macromutation does produce a novel, beneficial trait, that trait will almost certainly be very simple. 'Complex' traits cannot be produced by anything other than selection, and well-designed traits should be defined as complex. But what does 'complex' mean here, and how does the addition of this condition of complexity change our definition of good design? Maybe we will say that traits of complex design are those whose contribution to fitness relies on

[19] Dennett has long been a defender of such evolutionary models of creativity. See op. cit., note 17, and also P. Griffiths, 'Functional analysis and proper function', *British Journal for Philosophy of Science* **44** (1993), 409–22.

[20] For more thoughts on this see op. cit., note 14, chapter seven.

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interrelations between heterogeneous parts that would be exceptionally unlikely to arise together through macromutation. We could say this, but to do so threatens a form of creeping vacuity in the claim of monopoly. It threatens vacuity because it is a step on the path to defining 'well designed' as 'of a form most likely to be produced by selection acting on gradual variation'. If this is the definition of good design, then of course selection is the best explanation of the occurrence of good design. Arriving at this claim does not, however, signal a victory of good sense over creationism. We have seen that the monopoly claim is not needed in arguments against creationists. Better, perhaps, to avoid playing monopoly all together.[21]

[21] I am grateful to the audience at the Royal Institute of Philosophy where this talk was first given in February 2004, and to the audience at Shanxi University, China, where a revised version was given in April 2004. I also owe thanks for comments to André Ariew, Emma Gilby, Griff Gilby, Peter Lipton, Matteo Mameli, Hugh Mellor, Anthony O'Hear, Samir Okasha and David Papineau.

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