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Representational and Realised Design: Problems for Analogies between Organisms and Artifacts

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Introduction

In *Organisms and Artifacts: Design in Nature and Elsewhere*, Tim Lewens examines the role and value of the artifact metaphor for understanding the design of organisms and, to a lesser extent, for understanding the design of artifacts themselves. Lewens sketches an "artifact model for organisms" and an "artifact model for artifacts", which models he says are "isomorphic".[1] In the use of metaphors or analogies, however, we can appear to find something that is similar to A in B, because our view of A has already been shaped by our understanding of B. This is the thought I explore in this paper: the extent to which Lewens' models are shaped by a prior view of artifacts in terms of organisms and the framework of biological thought. From this same perspective, I also consider the idea of "natural design" as developed by Colin Allen and Mark Bekoff.[2] Natural design is a heuristic for the design-like features of the traits of organisms, based on intuitions about the design of artifacts. Is Allen and Bekoff's heuristic congenial to the world of organisms, however, because that is its origin? Is there more to the ontology of artifacts than these exercises allow or consider?

Lewens' "Artifact Model for Organisms" and "Artifact Model for Artifacts"

In Tim Lewens' artifact model for organisms, "ancestral organisms" give rise to a set of "variants available for selection", nominally S1, S2 and S3. The "constraints on variation" ensure that other possible variants, nominally S4, S5 and S6, are unavailable for selection. "Selective pressures" on the three available variants then result in the selection of S1.[3]

In his artifact model for artifacts, a "single artificer" draws on her "cultural resources" to produce "candidate problem solutions" - again, nominally, S1, S2 and S3. The "limitations on candidates" ensure that other possible candidates, S4, S5 and S6, are unavailable or not produced for consideration. The "criteria for choice" - the equivalent of "selective pressures" - then eliminate S2 and S3 from the available candidates and S1 remains or becomes the "finished artifact".[4]

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[1] Tim Lewens, *Organisms and Artifacts: Design in Nature and Elsewhere*, (Cambridge, Mass.: MIT Press, 2004), pp. 45-46.

[2] Colin Allen and Marc Bekoff, 'Function, Natural Design and Animal Behavior: Philosophical and Ethological Considerations'. In N. Thompson (ed.), *Perspectives in Ethology II: Behavioral Design*, (New York: Plenum, 1995), pp. 1-46.

[3] Lewens (2004), p. 45.

[4] Lewens (2004), p. 46.

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I raise three problems with these models.

(i) Representational and realised designs: two modes of selection, two kinds of environment

We think of an artifact such as a mousetrap as *embodying* design: the mousetrap, we may say, embodies its design. The *design for* such a mousetrap, however, is not embodied in the mousetrap; it is embodied, typically, in a set of drawings or a model (as well as in the designer's head). The design of the mousetrap is thus *represented* in the drawings or model and *realised* in the built mousetrap. The purpose of the designer's representation of her imagined mousetrap is to help bring into existence just such an artifact, the purpose of which, in turn, is to catch mice - unlike, say, an oil painting of an actual or imagined mousetrap, whose purpose would be aesthetic pleasure. The distinction I am suggesting here, then, is between what I shall call *representational* design, as in the *design for* a mousetrap, and *realised* design, as in a mousetrap built to this design.[5]

Given these two kinds of design, we can distinguish two modes of selection and two kinds of environment in which, or in relation to which, selection occurs. Taking selection first, we can distinguish the selection of a design for an artifact from the selection of an artifact embodying this (or some other) design. So we distinguish the selection by a furniture designer or maker of a design for a new lounge chair, X, from the selection by a consumer of X (or of some instance or token of X), rather than of Y or Z, by the same or another furniture maker. Lewens' artifact model for artifacts approximates the *former* mode of selection, the selection by the designer or maker of a design for an artifact that is then realised as the "finished artifact" (or artifact type). The artifact model for organisms, on the other hand, more closely resembles the *latter* mode of selection: a population of realised design variants of some novel organism or lounge chair is available for selection, and the relevant environment (nature, the market) selects one or other of these variants.

Now consider how representational designs, such as the designs for buildings in Australia, are selected. If we ask, for example: 'Where does the Building Code of Australia (BCA) fit into Lewens' model for artifacts?' then, on the face of it, the BCA is one of the "criteria for choice" for building designs in this country, the equivalent of a selective pressure on

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5   In the paper delivered in the table session at the CEPHAD 2010 conference, I used the terms 'disembodied' and 'embodied' for 'representational' and 'realised', respectively [Greg Bamford, 'Disembodied Design and Selection: Problems for the Analogies between Organisms and Artifacts', *Copenhagen Working Papers on Design* (2010 No. 1): 21-23]. But since 'disembodied design' has to be read in this case merely as 'not embodied in the thing for which it is a design', the latter pair is, I think, an improvement. In the session, Louis Bucciarelli suggested 'unrealised' and 'realised', respectively, for which I am grateful. ('Unbuilt' and 'built' would be the common equivalent pair of terms in architectural discourse.) I have substituted 'representational' for 'unrealised' or 'unbuilt', however, to avoid a possible confusion between the design for an artifact that is then realised or built as opposed to one that is not. 'Representation' is also more informative, reminding us of what such designs are *about* and thus also of the absent artifact problem – see Per Galle, 'Design as Intentional Action: A Conceptual Analysis', *Design Studies* 20 (January 1999): 57-81.

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organisms. But Australian architects know quite a lot about what the BCA contains and so tailor their designs accordingly. Thus, the BCA would also be one of the "limitations on candidates" - a constraint on variation - in Lewens' model. But the BCA consists to a large extent of *solution fields* for the features (or traits) of the building types it defines. For example, in Figure 1, the irregular hexagon defines the acceptable solution field for risers and goings of steps in public stairways. Thus, the BCA would also seem to be one of Lewens' "cultural resources", a kind of ancestral designer providing acceptable solution fields for aspects or elements of putative buildings in Australia.

Figure 1. Solution Field for Riser and Going Dimensions, Public Stairways, Building Classes 2 - 9, in the *Building Code of Australia.*[6]
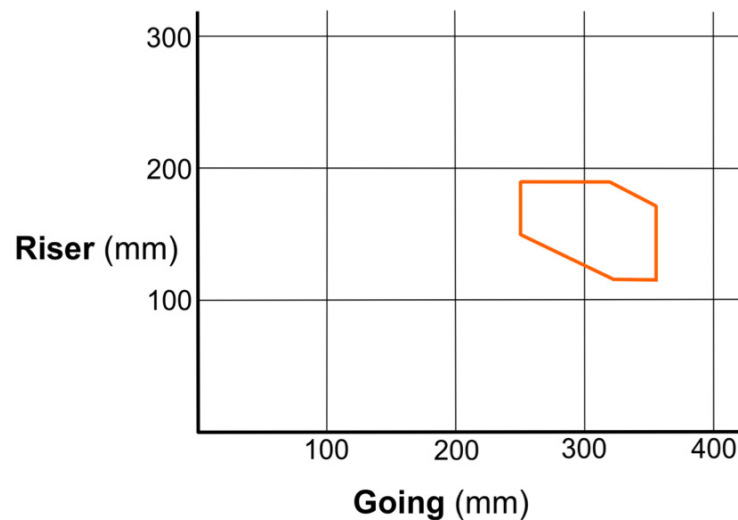
Turning now to 'environment', Paul Griffiths distinguishes two kinds of environment, "hypothetical" and "real", in relation to the selection of the designs for artifacts. He points out that, for example, the tapered tail of an old-fashioned racing car was intended "to reduce its drag coefficient", but that it failed to do so. The selection of this feature by the designer "occurs in a hypothetical environment constituted by the beliefs of the designer. When the designer has false beliefs about the real world this results in artifacts functioning well in his hypothetical environment when they do not function in the real environment." The tail of the racing car performed its function, Griffiths suggests, "only in the mind of the designer".[7]

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[6]   The *Building Code of Australia* (2008): Vol. 1, 202. In 'Without a godlike designer no designerlike God' (http://janmichl.com/), Jan Michl argues that in relation to intelligent design the plausibility of god as designer rests largely on the assumption of the designer as god. The BCA illustrates how much building design is a collective, historically based enterprise.

[7]   Paul Griffiths, 'Functional Analysis and Proper Functions', *British Journal for the Philosophy of Science* 44 (1993): 420-21. In relation to the selection of artifacts or realised designs, hypothetical environments also play a significant role. For example, consider the selection by a consumer of a new TV. This person may be content to replace his modestly sized TV with something similar, but he may also want to invite his friends around to watch important sporting matches - and all of them have large flat screen TVs. This novel possibility or hypothetical environment he both imagines and desires may then influence his selection of a TV.

The contents of the hypothetical environment in which, or in relation to which, a building design is selected include, in addition to a building code such as the BCA, items such as the client's brief, the architect's site analysis, local planning codes, the policies of any financial institution funding the project, national occupational health and safety legislation, and so on. Each of these elements of the hypothetical environment, like the BCA, is itself *an object of design*. Under natural selection, however, it is an indifferent actual or real environment that selects (untailored) variants of organisms or their traits. Hypothetical environments reflect the mental feature of *intentionality*: the BCA is *about* the buildings that would be certified or selected in this country; the client's brief is *about* this one building proposal in particular, and so on. The BCA defines what is generally permissible in Griffiths' real environment; the client's brief defines what is wanted in this case in that environment.

Can Lewens' models be isomorphic? How coherent or helpful is the underlying analogy?

(ii) Solution fields versus solution candidates

Architects, and many other designers, do not typically produce the alternative solution candidates, S1, S2 and S3, that Lewens' model for artifacts envisages. Industrial designers or stone-tool makers may do so. They produce type designs for many, often relatively inexpensive, tokens, and so it may be feasible or not uncommon in these practices to produce alternative solution candidates either as representational designs or as realised designs or prototypes. Photography is a paradigm case of such a practice. A photographer can effortlessly shoot many photographs of a subject, that is, she can realise many alternative solution candidates from which perhaps only one or two shots need be chosen. Architects, however, typically aim to produce just one (relatively complex and expensive) solution token. So Jørn Utzon did not produce alternative *solution* candidates for the Sydney Opera House, as representational designs, much less as realised designs, one after the other, on the site at Bennelong Point! The typical fare in discussions of natural selection, however, is of birds and their wings or earwigs and their penises, that is, of populations of organisms and their traits, as selected embodied alternative solution candidates or realised designs. And so corkscrews, knives or stone axes come to mind when comparisons are sought with artifacts, rather than one-off buildings, paintings or films.

How, then, do architects typically design, if not by way of producing and evaluating alternative solution candidates? The emergence of representational design has been accompanied by the development of design skill, reducing or removing much of the need for alternative *solution* candidates, especially prototypes. Instead, architects (and designers generally) evaluate alternative solution *fields*, as candidates for further development or elimination in the design process. A designer's sketch, for example, is a candidate solution *field*, not a candidate solution. Consider the architect who produces two alternative sketch plans for a house, an L-shaped plan and a C-shaped plan. If she chooses the former she is ruling out *every* C-shaped solution candidate, in advance of any such candidate being developed, and vice versa. The L-shaped plan is not a solution candidate, to show the client or take to a builder. At this stage, the sketch represents but a field of possibilities, the boundaries of which it loosely and provisionally defines, along with her other ideas for the project.

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Architectural design is, in general, a process of narrowing or refining solution fields, and this is common practice in art and design. The sculptor who carves a figure from a block of stone or the painter who renders the landscape before him is engaged in a continual process of narrowing a solution field until a final image, the solution candidate, is achieved.[8] So, there are not two missing, ready-to-build, Utzon designs, S2 and S3, for the Sydney Opera House. A winemaker can harvest her shiraz grapes and make the '2009 Solution Fields Shiraz' - she need not divide the harvest into thirds, make three wines, choose the best one, and pour the other two down the drain. That would be the kind of wasteful production only nature can afford.[9]

(iii) The construction of design problems

In designing the Opera House, Utzon constructed what he called the 'problem of the fifth façade' and produced a radical solution to it.[10] The fifth façade is the roof. From many vantage points around Sydney Harbour, Utzon recognized that one would be looking *down* on the roof of any building on Bennelong Point. Roofs can be large, unsightly or uninteresting things when viewed in this way and so roofscape became an especially important consideration for him (although not, apparently, for many other competition entrants). The problem of the fifth façade may seem obvious, but it arose only because of the observations Utzon made in the context of the beliefs or preferences he held as an architect.

Design problems in artifacts are not given; they are not imposed or set down by the environment, hypothetical or real. In John Searle's terms, design problems are 'observer-relative' or have a 'subjective ontology'.[11] It may invariably be the case that one of the design requirements for a prison is that its inmates should not be able to escape, but a given is not (yet) a problem in design. A given has to be understood and accepted by the designer to influence the design. Moreover, what forms of escape are common or anticipated? Is the advice of the prison authorities adequate in this regard? What is the importance of preventing escapes relative to the other requirements for the prison, in the context of the budget? And so on.

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8   See Gombrich on the art of illusion in Ernst Gombrich, *Art and Illusion: A Study in the Psychology of Pictorial Representation*, 4th ed., (London: Phiadon Press, 1972).

9   Francisco Ayala, 'Design without Designer: Darwin's Great Discovery'. In William Dembski and Michael Ruse (eds.), *Debating Design: From Darwin to DNA*, (Cambridge: Cambridge University Press, 2004), pp. 70-71. Solution fields introduce economy and efficiency into design compared with solution candidates, considered either as representational or realised designs.

10   *Sydney Opera House: Nomination by the Government of Australia for Inscription on the World Heritage List 2006*. (Canberra, ACT: Australian Government Department of Environment and Heritage, 2006), p. 30. http://www.sydneyoperahouse.com/uploadedFiles/About_Us/Ad_Hoc_Information_Pages/WorldHeritageNominationDocument.pdf.

11   John Searle, *The Construction of Social Reality*, (London: Penguin, 1995), pp. 9-23. Searle holds that functions in both artifacts and organisms are observer-relative, so design problems, even in organisms, would be likewise.

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What I have elsewhere called a meta-problem is an acute example of problem construction. Consider a premature babies' ward twenty years ago that looked and functioned like a laboratory, with the babies mere extensions of the machines that kept them alive. If the hospital decided to extend the ward, and no-one challenged the existing state of affairs, it is likely the brief for the extension would presuppose an environment of just the same kind. But suppose that someone were to ask (as someone did in a similar case), 'Might the babies not do better if the ward were less like a laboratory in appearance and operation and more like, say, a nursery?' This question implies there is a problem with the brief itself, and thus with *any* solution to it that might otherwise be considered appropriate. I call this kind of problem a meta-problem. The solution to a meta-problem is not a design, but a revised brief or a revised design problem.[12] In the end, designers and their clients negotiate and construct the problems they would solve.[13]

Lewens provides an example of a limitation on a solution candidate for a design problem that indicates a quasi-objective view of problems. He points out that "the Greeks would not have thought to use PVC" for furniture covering. In a similar vein, Paul Griffiths says: "In biological competition, there is only a certain range of available alternatives. Maori canoe designers did not have to consider the idea of the winged keel. It was not part of the 'population' of designs that were in competition at the time."[14] The Greeks or the Maoris could not consider such options because they did not *know* about them. But solution candidates for artifacts are constrained not only by what you *cannot* consider but also by what you *refuse* to consider.[15] For example, an architect who believes that the manufacture of PVC has an unacceptably deleterious effect on the environment may refuse to consider PVC pipe, even though it may be readily available and would otherwise be the 'preferred solution' to the problem in hand. PVC pipe, we might say, doesn't make the short list.

Designers routinely constrain themselves in defining their problems or shaping their solution fields, often quite severely. Indeed, self-imposed, restricted palettes are an enduring feature of much good design, even if the writer George Perec may not have benefited much from his curiously self-imposed constraints. According to Jon Elster, in Perec's novel, *Les Revenentes,* the only vowel he employed is the one found in his name, 'e', whereas in another of his novels, *La Disparition*, 'e' is nowhere to be found![16]

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12   See Greg Bamford, 'From Analysis/Synthesis to Conjecture/Analysis: A Review of Karl Popper's Influence on Design Methodology in Architecture', *Design Studies* 23 (May 2002): 253.

13   Steve Harfield, 'On the Self-Construction of Design Problems' In *Connected: 2007 International Conference on Design Education 9-12 July 2007*, pp. 1-5. Sydney: University of NSW.

14   Griffiths (1993), p. 419.

15   Barry Schwartz argues that consumers are often presented with daunting ranges of choice such that it is both rational and emotionally healthier to resort to conventions or practices that place *a priori* restrictions on such ranges. See Barry Schwartz, *The Paradox of Choice: Why More is Less*, (New York: Harper Collins, 2004).

16   Jon Elster, *Ulyses Unbound: Studies in Rationality, Precommitment and Constraints*, (Cambridge: Cambridge University Press, 2000), p. 175.

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As an analogy for design problems and solutions in artifacts, how far do we get with Lewens' idea of problem setting and problem solving in organisms - "a multiplicity of selection pressures, with organismic possibilities determining which might be answered"?[17]

Natural Design

"Natural design", according to Colin Allen and Marc Bekoff, "entails both the possession of biological function and a history of progressive structural modification under natural selection for improved performance of that function."[18] Thus, "to say that the wings of (most) birds are designed for flying is to say that (i) enabling flight is a biological function of bird's wings' and (ii) extant morphological forms of such wings are the result of natural selection for variants that were better adapted for flying than earlier forms."[19] For others like Philip Kitcher, such progressive structural modification of the wing is unnecessary and function alone is sufficient for design.[20]

Allen and Bekoff appeal to artifacts to explicate their idea of design. In a drinking establishment called the *Dixie Chicken*, they tell us:

> Stag's heads function as wall decorations. They are clearly not designed for that purpose (although the stags' heads were presumably put on the wall, intentionally, hence by intent-design.) Likewise, the function of a rock on a desk may be to hold down loose papers, but unless the rock has been modified by, for example, having a flat base chiselled into it, it is not appropriate to say that this object was designed for the purpose of holding down papers. Thus, having a function does not entail being designed for that function."[21]

It is true that Allen and Bekoff's unmodified rock has not been designed or shaped as a paperweight, which is now its function. Nonetheless, the mere relocation of a found object can be the extent of an act of design. The first person to use a safety pin as an earring - as

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17   Lewens (2004), p. 85.

18   Allen and Bekoff (1995), p. 3.

19   Colin Allen and Marc Bekoff, 'Biological Function, Adaptation and Natural Design', *Philosophy of Science* 62 (December 1995): 616.

20   Philip Kitcher, 'Function and Design'. In Colin Allen, Marc Bekoff and George Lauder (eds.), *Nature's Purposes: Analyses of Function and Design in* Biology, (Cambridge: Cambridge University Press, 1998), p. 479.

21   Allen and Bekoff, 1995, p. 33. It is true that the heads of stags are not designed to decorate the walls of American bars, but it is false that these decorative items have not been *designed*, by the taxidermist. Allen and Bekoff (December 1995: 614) repeat this argument with the example of a stuffed bear in a ferocious pose and they acknowledge that the pose is designed. In making, however, materials are sometimes used 'raw' or as found; often they are used as manufactured or treated; and sometimes they are used as manufactured or treated so as to resemble their original as found state. The stag's heads in the *Dixie Chicken* and the seemingly ferocious bear are instances of the latter. It is true that stags and bears are not designed for human use as decoration, but nor are trees designed for posts or beams, clay for bricks or the sun for the pattern of shadows it may be co-opted into casting on a facade.

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ironic body adornment - I would count as a designer. This point should be clear when several such objects are involved, for example, when found objects such as shells, seed pods, driftwood or pebbles are composed or arranged for display in a bowl or on the mantle-piece of a holiday house. To fail to see that such compositions are designs, even though none of their elements has been designed, is to fail to see the wood for the trees.[22] There is not just the bare intention here (so-called intent-design) for these objects to be visible. A collector decides how and where the objects will be displayed, how they sit in relation to one another and how this composition affects how the objects are likely to be viewed, seen or noticed in the holiday house. Figure 2 illustrates how the architect, Rex Addison, strung necklaces of fishing sinkers to act as counterweight cord pulls for timber screens to the rooflight vent of the living room of their house.

Figure 2. Designing and Matching: Sinkers as Counterweight Cord Pulls for Timber Screens to a Rooflight Vent, Living Room, Taringa House, Brisbane.[23]

In the famous Ryoan-ji sand garden in Japan, the placement of fifteen nondescript rocks or stones is the central feature of that design.[24] Lorraine Kuck provides a detailed analysis of this composition in terms of balance and rhythm. Under the latter category, she remarks of the sense of movement in the composition as follows:

> It hardly seems possible, indeed, that stones could convey such dynamic feelings as these do. In general, there is a strong sense of flowing movement from left to right,

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[22]   Allen and Bekoff (December 1995: 614).

[23]   Rex Addison, architect. http://www.rexaddison.com.au/.

[24]   Lorraine Kuck. *The World of the Japanese Garden: From Chinese Origins to Modern Landscape Art*, 1st ed., (New York: Walker/Weatherhill, 1968), p. 164.

the conventional direction. If we think of the garden as a river, there is no doubt in our mind in which direction it is flowing. From the largest group on the left, the others seem to taper away, but direction is indicated also by a subtle obliquity of direction in the position of the stones. Those that are upright are not exactly perpendicular but slant slightly to the right, while all the long, reclining stones seem to point in the same direction. There is just one exception to this directional movement; the fourth group from the left is definitely reversed in direction and straight upright. It is as if it were standing against the current.[25]

One last example: suppose a group of design students are asked to walk through a forest or along a beach in search of objects that, as found, would serve the general function of a paperweight by some means other than the continuous application of their mass acting under gravitational force - so, not paper*weights.* This is now a design problem. The students will need to imagine novel forms of restraint and perhaps novel conditions of use as they inspect their surroundings for likely objects. So, could this unusually shaped piece of driftwood be a kind of cage for a stack of paper? In lieu of the fridge magnet that pins our household bills to the side of the refrigerator, would this tangle of little branches, arranged in a vase on the kitchen bench, snare those same bills, perhaps rolled or folded, and keep all of them more attractively in view so we might remember to pay them on time?

The explanation for the absence of design in the case of Allen and Bekoff's intact rock as paperweight is that we have only to recognize or assume that the rock in question will satisfy our requirements, under the relevant conditions, to be selected. Thus, *design* is not called for in that case – there is no problem solving or novelty involved.[26] Conversely, modifying a rock to make a better performing paperweight need not entail design. The properties of many objects are routinely modified to satisfy our purposes without involving design, as

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[25]   Kuck (1968), p. 166.

[26]   Four conditions for producing a design, D, for an artifact, or a type of artifact, A, are:

(i) Representation	I produce a design, D, to represent A …
(ii) Purpose	… such that A would satisfy some set of requirements, R, under conditions, C.
(iii) Problem-solving	For me, satisfying R under C is a problem for which…
(iv) Novelty	… D is a novel solution candidate for A.

'R under C' constitutes the constraints on D. Condition (ii) eliminates day-dreaming; (iii) eliminates already knowing or assuming what will satisfy R under C; (iv) eliminates copying or selecting an existing solution. A note on intelligent design: on the above four conditions, design, as we know it, seems like an exercise in pandering to our weaknesses and compensating for our dismal limitations! We design only because we are *dissatisfied* with existing states of affairs and the existence of *problems* implies ignorance or uncertainty, however temporary, on our part. Our hearing and our sight begin to fail and we can't bear the consequences, so we design ear trumpets and eye glasses to prop up these failing senses. Not much of a template for super-human activity? For a more detailed account of (roughly) the above four conditions, see Greg Bamford, 'Design, Science and Conceptual Analysis.' In Jim Plume, ed, *Architectural Science and Design in Harmony: Proceedings of the joint ANZAScA / ADTRA conference, Sydney, 10-12 July, 1990*, pp. 229-38. Kensington, NSW: University of NSW School of Architecture, 1991.

making a cup of tea illustrates. I am familiar with the procedure or recipe for modifying the properties of water, tea leaves, kettle, cups, and so on that is required, and I simply enact that procedure or follow that recipe. I just make the tea; I do not design and make it.

To sum up, we can design leaving objects intact - designing and matching, for example, (finding objects to match our ideas), rather than designing and making (transforming objects or materials to bring them into line with our ideas). As the safety pin as earring and the fishing sinkers as cord pull illustrate, and as Searle makes plain, *semantic* functions can be imposed on physical objects without changing their intrinsic properties, or indeed even their relational properties.[27] This is a distinctive and familiar feature of children's games ('That pile of dirt is the pirate ship and this pile is an island …', and so on).[28] On the other hand, we can intentionally modify objects to better suit our needs without designing anything. Natural design theorists like Allen and Bekoff overlook these complexities presumably because representational design is effectively absent from their analogy and natural selection acts on physical variations. In natural design, there is designing only if there is making (or realising) and selection, but an artifact can be designed without being realised or realised without being selected.[29]

Conclusion

In the study of artifact design, we need to distinguish representational from realised design, and a hypothetical from a real environment. We need to recognize the function of hypothetical environments in the selection of representational (and realised) designs, the emergence and function of solution fields in representational design, and the dependence of design problems on our beliefs about the world and how we want it to be. Understanding the design of artifacts is an empirical inquiry, no less than is the understanding of how and why organisms are as they are or come to be that way.

I have attempted above to sketch some of the elements or aspects of a conceptual framework for this task, by way of a contrast with what I see as the limitations of some biological analogies in this regard. This is not to say that unified accounts or comparisons of function, use or design should not be attempted for organisms and artifacts, but it is to identify those features of artifacts and how they come about that any such account needs to accommodate or explain.

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[27]   Searle (1995), pp. 13-23.

[28]   In the game of 'red rover', as we played it, most of the children gathered at one side of the school oval with the remainder in the centre. Those at the side then tried to run to the other side of the oval without being tagged by anyone in the centre. Once tagged, you joined the taggers until no-one was left to run, and the game started over. The game bestowed particular meanings on the sides and centre of the school oval without altering any physical properties of the landscape.

[29]   If only traits that are *selected* are designed, is only S1 in Lewens' schema naturally designed, and not S2 or S3?

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