Design and Responsibility

The Interdependence of Natural, Artifactual, and Human Systems

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This essay explores design as the imposition of human purpose onto nature. It argues that understanding design requires that we be able to distinguish among three different kinds of systems: natural, artifactual and human. Each kind has its own distinct requirements for stability and sustenance, yet each is also dependent upon the stability and sustenance of the other two. Design entails crafting artifactual systems by imposing aims and values from human systems onto the raw materials of natural ones. Effective and responsible design, moreover, is undermined when distinctions among systems are ignored or when one kind is treated as another. Life as we now live it is increasingly dependent upon the stability of our artifactual systems; this, in turn, is increasingly dependent upon our ability to make the value judgments by which alone we can determine that a design is worth making and how best to realize it.

1 Introduction

Design is the imposition of human purposes onto nature. What results is neither human nor natural, but something that exists in a world of its own, where form and function cannot be explained solely in human or natural terms. In modern times, this world of artifacts, equally alien from us as from the earth out of which it was made, is nonetheless our primary home. We depend on its presence and stability for our daily lives to transpire unproblematically, and we more often than not turn to it when life's problems send us in search of remedy. Although we live in this world —not so much given as made, and increasingly the product of our own artifice—we now often live as though we were scarcely aware of its unique character as an object of design. The admixture of human purposes with the stuff of nature that constitutes that character includes particular requirements for sustenance and stability, and demands of us an astonishing measure of responsibility in choosing what artifacts should exist, how they should function, and how long they should endure.

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None of the artifacts that make up this world function in isolation. Whether it is a tool or building, computer application or ballpoint pen, every artifact is suspended in a network of social relations that brought it about, see to its use, compass its ultimate disposal and, importantly, link it to other artifacts. The specifics of an artifact's design also arise in social contexts and it is only within such contexts that its various functions can be deployed. Light does not issue from a lamp alone, but from the interaction of the lamp with someone who turns it on and makes use of the illumination. More complex undertakings, such as the mining of coal, the manufacture of automobiles, or the irrigation of extensive farmlands, entail even greater and more subtle networking of technical and social elements. Along with the modern expansion of such enterprises, there has been a growing effort to understand this world of artifacts not as individual technologies but as "socio-technical systems."

The idea of socio-technical systems has its roots in the middle of the 20th century. Cybernetics (Wiener, 1962 [orig. 1948]), operational research (March and Simon, 1993), and systems theory (Bertalanffy, 1968), each of which came of age during the Second World War, made seminal contributions to treating in singular terms a collection of individual devices functioning together. Occasionally, studies in these areas would also assess the role of the teams that operated those systems. It was, nonetheless, the work of the Tavistock Group, and that of Emery and Trist (1960) in particular, that in the late-1950s began to address explicitly what they called "socio-technical systems" (indeed, Emery and Trist most likely coined the term). Here the key idea was, for a given task, to see both devices and people as a functioning unit, and to apply this perspective to the conception, design, application and assessment of what was then taken to be a socio-technical system. In recent years, both the practice of and the need for this perspective has been recognized in numerous areas.

All artifacts are also embedded in the social world in a simple but fundamental sense. That is, all artifacts, to one degree or another, are socio-technical systems because they are, to one degree or another, prosthetic: they are extensions of us. What our artifacts do is always in some way a matter of what we do with them. Accordingly, they must be understood not only in terms of their "built-in" functions but also with respect to the human activities in which those functions are deployed and the human purposes, or their lack, which they serve. Even the simple case of an alarm clock reflects this prosthetic character. It is often observed that an alarm clock once set and turned on can function autonomously, that is, without our immediate intervention. This does not mean that it is totally autonomous, however. No technology ever has been. If I were to attach the alarm clock to a bomb, it is I, not the device, who would be held responsible for the explosion. In this sense at least, our artifacts are inescapably prosthetic in character, both instrumentally and morally. Indeed, even when we design our technologies to have a degree of instrumental autonomy, they remain always morally prosthetic.

There is another important sense in which artifacts are connected to human affairs, in this case to human values. No design can be explained solely by appeal to its functions, intended or otherwise, because a given set of functions can always be achieved by more than one design. This is why all lamps are not alike, nor are

all cars, water bottles, power plants, software interfaces, etc. Along with function, the design of an artifact must be explained in terms of explicit or implicit value choices made by its designer. Indeed, the mere fact that an artifact exists suggests that someone made the value judgment that it was worth having in the first place. Such value judgments can be aesthetic, moral or both. But they are always part of design. So the mixing of human purposes with the stuff of nature results in artifacts that necessarily reflect the intentions and the values of their makers.

Yet, to understand better how socio-technical systems are embedded in the human world, including the formative role that value judgments play in that world, I believe our conception of socio-technical systems must be expanded. In particular, we need to see how the design of our artifacts, particularly the complex ones upon which life as we now live it depends, is bound up with three distinct but interdependent kinds of systems: natural, artifactual, and human. Accordingly, in what follows, I explore some of what I believe is called for in a broader understanding of what we do when we impose human purposes onto nature.

2 Systems and Design

In his 1893 essay, "Evolution and Ethics," T. H. Huxley (2002 [orig. 1896]) considers the difference between a jungle and a garden in his exploration of the mechanisms of evolution. Today, with developments in evolutionary theories and the broad establishment of environmental studies, the difference between a jungle and a garden may seem obvious or even trivial. I think the distinction is well worth revisiting, however, because it holds implications that are vital to understanding how the world upon which modern life depends is constituted.

In modern terms, a jungle can be explained by appeal to the push and pull of evolutionary adaptation, the vagaries of weather, and other workings of nature. We can also easily point to jungles as one of several kinds of "ecological niches." Indeed, they can be seen as exemplars of what I would like to call "natural systems." That is, they are systems whose activities can be explained by appeal to natural factors (in a way, at least, that distinguishes those factors from ones rooted in human agency or activity). The field of environmental studies has given us ever greater sophistication in specifying the characteristics of natural systems, including how they operate under the impact of human activity, reflecting the distinction Dewey (1938) notes between our "living in" and "living by means of" the environment.

Natural systems, like all systems, have their own unique requirements for sustenance and stability. In the short-term, a jungle needs water, nutrients and sunlight to sustain itself as a healthy living system. For its long-term stability, that is, its ability to maintain the crucial balance between stagnation and chaos that enables it to remain a jungle, a jungle needs internal regulators that are resilient in the face of broader changes in the climate, encroachment of new species, etc.

Significantly, the natural forces we can find at work in a jungle are no less present in a garden. Indeed, if we fail to look after a garden's stability and sustenance

needs as part of the plant kingdom, providing water and sunlight, for example, it will fade or die. In this sense, a garden is as much a natural system as a jungle is. Unlike a jungle, however, what goes on in a garden cannot be explained solely by appeal to the workings of nature because a garden is also an artifact. It is a human creation, a jungle upon which a design of uniquely human origin has been imposed. Any particular characteristics or requirements it may have that arise from it being a garden rather than a jungle (tilling, weeding, fertilizing, etc.) find no origin or criteria in nature. Rather, they are utterly human. And if we fail to look after a garden's stability and sustenance needs as an artifact, it will revert all too quickly to the state of nature from which it was drawn. Accordingly, any satisfactory explanation of the form and function of a garden requires appeal to the requirements of nature and to the requirements of its design as an artifact.

This is true of all artifacts. Whether gardens or cities, tools or technologies, automobiles or the Internet, all human creations are a mixture of natural materials and human purposes, and both aspects demand our attention. A bridge must be understood equally in terms of the functions its design affords, and the properties of its raw materials that afford its design (Cook and Brown, 1999). One the one hand, the form a particular bridge takes can by keyed to the functions of spanning a particular distance, supporting a range of loads, etc. On the other hand, its form needs to be accounted for in terms of what the bridge is made of. A bridge built to serve a specific set of requirements for span and load would look quite different if its raw materials were different—stone would afford one range of design possibilities, steel another.

Because such systems are artifacts, and because their forums and functions cannot be adequately explained in terms of the properties of natural systems alone, I call them "artifactual" systems. (I prefer this term to "man-made" since it is gender-neutral, and to "artificial" because that can suggest "phony," which artifactual systems clearly are not. "Artifactual" is also meant to remind us that such systems are human creations.)

As human beings, we interact not only with nature and our artifacts but also with one another. This includes all forms of intra-human interaction, from dialogue to teamwork to organizational behavior to the modes of discourse and forms of activity necessary to vital public life. That aspect of human interaction that is distinct from the mediation of natural or artificial systems is what can be understood, following Vickers (1996 [orig. 1965]; 1983), as the workings of "human systems." If I communicate with you by yelling across a field or speaking over the telephone or sending an email over the Internet, there are natural and artifactual systems that afford our communication. But they alone cannot account for the meaning of what we say or for the net of expectations that the communication fulfills or for the value that we place on what is said. All of that transpires within a human system that you and I share, that we most likely inherited from any common social groups to which we belong and from human culture in general. We may speak over the telephone, but we communicate with each other. The success of our communication is at least as much dependent upon the presence and stability of a set of human norms that make our communication meaningful and actionable, as it is on the clarity of the signal carried through the telephone.

Human systems entail those standards that give form and direction to human activity, particularly, our aesthetic and moral values; they are unique among systems in that they have an axiological dimension. The actions we take and the choices we make reflect our values. They can also be seen in what we do with respect to all three kinds of systems. How we shape or despoil nature, what artifacts we decide to create and how we design and use them, and the ways we treat one another all testify to what we consider worth doing and which ways of doing them we find appealing or desirable. In explaining the form a garden takes we necessarily refer to those values of distinctly human character that have been incorporated into the garden's design: the aesthetic traditions that enable us to distinguish an English garden from a Japanese one, and by which we judge one garden to be modest and another world-class (for a parallel exposition of systems and ethics, see Cook, 2005).

In this sense, a bridge is not merely a static physical object. Just as an understanding of its design must include the affordances of its material, it must also include the values of its designers. Why it is built and located where it is, why it enables some forms of traffic and not others, why public funds are committed to a grand appearance when a more modest bridge could have the same carrying capacity, all these must appeal to the workings of the human systems within which the bridge is conceived, built and maintained. Conversely, no adequate explanation of why the bridge has the particular physical dimensions and properties it does can be given without reference to the values and purposes of the human systems in which it came to be. A bridge, like all artifacts, is the product and the embodiment of natural, artifactual, and human systems.

This distinction among these three kinds of systems finds a reinforcing parallel in the distinctions Hannah Arendt (1998 [orig. 1958]) draws among labor, work and action in her examination of human activity. Indeed, Arendt describes the whole of human activity as made up of those three distinct forms. In each case, I would apply her focused treatment of activity to the broader notion of systems.

Labor for Arendt is that part of human activity that confers to maintaining ourselves as biological beings. "Labor," Arendt says, "is the activity which corresponds to the biological process of the human body, whose spontaneous growth, metabolism, and eventual decay are bound to the vital necessities produced and fed into the life process by labor." (Arendt, 1998, 7) Seemingly, at the individual level this would at minimum include getting food and drink, protecting ourselves from the elements, and dodging predators. On such group levels as a community or even the species, it would include activities like adapting to the local environment and reproducing. All this constitutes a complex of interconnected and interdependent activities, which we share to one degree or another with other species. These activities are part of the biological world, and as such are part of nature. Labor, then, is that aspect of human activity that is given over to maintaining ourselves as natural systems.

Work, as Arendt defines it, is concerned with bringing about and sustaining the "world of things, [that is] distinctly different from all natural surroundings." (Arendt, 1998, 7) That is to say, work brings about the world of artifacts. These artifacts are distinctly human (other species may make things, but they do not make human things), which is to say they are the result of human purposes imposed upon nature.

Together they constitute a network of objects and gadgets within which we increasingly live and whose presence and stability in the modern world are evermore necessary to any form of life we might recognize or find acceptable. Work, therefore, is that aspect of human activity that creates and maintains our artifactual systems.

Action, in Arendt's view, is that aspect of human activity that "goes on directly between men without the intermediary of things or matter ..." (Arendt, 1998, 7). I would make this point a bit more broadly. It is not as though activity necessarily does not involve the mediation of things and matter. Rather, action is that part of human activity which is distinct from such mediation. "Things" are what make up the artifactual world and "matter" is the substance of nature. Both things and matter can provide the means by which humans interact, but neither can constitute the content of that interaction, nor provide the ends that it serves. Action, thus, is that aspect of human activity out of and within which human systems are formed and endure.

All three kinds of systems also interact with one another, and the flourishing of one can depend on the stability of the others. Just as we can see the artifactual system of a garden fail when we ignore its needs as a natural system, so can we see technologies fail when we ignore the requirements of the human systems within which alone they can function. Likewise, the fact that a garden will revert all too quickly to jungle if its needs as an artifactual system are not met has parallels in the case of cities, organizations and technologies, each one of which has its own version of reverting to jungle. The character of our values cannot be obscured or offset by the character of our artifacts.

Human beings live within a network of systems of these three kinds. In the 21st century, the successful functioning of our ordinary daily lives, to say nothing of our prevailing under exceptional circumstances, is utterly dependent upon the flourishing and stability of these interdependent systems (Cook, 1995). In our day, the design and maintenance of this network of systems is, I believe, a prime moral responsibility of humankind, if for no other reason than that our very existence is now utterly dependent upon it.

3 Design and Responsibility

3.1 Mislabeling Systems and the Fallacy of Counterfeit Naturalism

Because different kinds of systems have different properties, including different requirements for sustenance and stability, dealing with one kind as if it were another can be anywhere from impractical to irresponsible. It is a conceptual and practical mistake, for example, to treat an artifactual or human system as if it were a natural one. Yet, this is often done. It is also the most dangerous form of mischaracterization of a system since it tends to occlude the role of values in the workings of artifactual and human systems. For example, I recently heard a noted economist remark that, "jobs, like water, naturally flow downhill to the cheapest provider." Technically

speaking, however, there is nothing "natural" about this at all. Economies and job markets are not part of nature, they are systems created by people. The way jobs "flow" is a result of how we design the artifactual systems they are part of. Treating this as natural leaves no basis for assuming responsibility for what it may entail.

Treating artifactual and human systems as natural ones, in particular, amounts to what I call "counterfeit naturalism." If "naturalism" can be defined as understanding something in natural terms (lightning as being caused by weather conditions rather than by Zeus), then "counterfeit naturalism" would mean understand as natural something that is not, particularly when this can be misleading. In this respect, counterfeit naturalism entails at least two significant pitfalls bearing on our understanding of systems.

First, the more we engage in counterfeit naturalism, the more likely we are to diagnose problems and design solutions that may be appropriate to natural systems but not to artifactual or human ones. If we think of the flow of jobs to the cheapest provider as natural, it could make sense to design governmental policies aimed at avoiding interference with this "natural" process. (Indeed, this can even include a sense of "natural" standing in for "good" or "proper.") However, if we think of this in terms of systems we have made, it could make more sense to consider policies designed to redirect or curtail that flow.

The second issue derives from the fact that we generally do not see ethics as part of natural systems. We may hold ourselves responsible for how we treat nature, but we do not find ethics at work within nature itself, particularly in any way that entails the notion of responsibility. No one holds hurricanes morally responsible for the damage they cause. We do, however, hold people morally responsible for what they do with the aid of tools or teams. So, counterfeit naturalism undermines our ability to deal responsibly and effectively with the ethical aspects of human and artifactual systems because it treats them as natural systems that, like hurricanes, have no obvious moral dimension. If the flow of jobs is taken to be a natural occurrence, it would make no more sense to debate the ethics of it than to debate the ethics of the tides.

This is also seen when we attempt to justify our design choices by making claims like "we are going with what works" or "my opponent's plan won't work." Comments such as these point to the functional aspects of human and artifactual systems, but imply that, like natural systems, they are without a values dimension. Appealing only to the functional obscures the role that values play in shaping both the choices we make and the consequences of those choices. Our design choices are never solely about what will and will not work. They are also always about the aims we want to further and what we consider appropriate ways of pursuing them. Keeping the discussion at the level of what supposedly will and will not work misses, or dodges, the need to deal effectively with the values inherent in all design choices.

3.2 Design and Values Infrastructures

Just as natural systems can, and artifactual systems should, afford the purposes of human systems, human systems have what I call "values infrastructures" that

inform the way we treat nature and how we design artifacts. A values infrastructure is made out of what is valuable to individuals and groups about themselves, the physical and social spaces within which they live and work, the various means that they employ to do what they do, and so on.

The connection between our values infrastructures and what we do is a strong one, though at times not acknowledged, as counterfeit naturalism suggests. What is valuable to you plays a significant role in what you consider worth doing, how you like to see it done, with whom you choose to associate, what goals you think are worth striving for, etc. (for a similar treatment, see Schein, 2004 [orig. 1985]). What we find valuable shapes what we do. (By definition, if values did not influence how we act, it would be odd to call them values.) That is, the design of a community's artifacts both embodies and affords the expression of the values to be found in its values infrastructure. (Getting a sense of an individual's or group's values infrastructure can be tricky. I have found that if you ask people what their ethics or values are, they are often uncomfortable. However, if you ask what is valuable to them about their job or the spaces in which they live and work or their associations with other people, an interesting and useful conversation often ensues. And if they can show you, or you can observe examples of this in the course of their actual work practice or social interactions, the picture of the values infrastructure can become even more robust.)

The importance of values infrastructures to the design of technological artifacts and the social practices they are embedded in can be seen in the case of a project team I observed in a high-tech research and development laboratory. The team was designing an early computer conferencing application that could establish a network of "virtual offices" through audio and video connections along with the virtual equivalent of pieces of typical office equipment, such as a whiteboard, a filing cabinet, a book case, etc. A primary aim in the development of this application was making it possible for each user to design a virtual office, through his or her computer, by setting up and configuring audio and video links and organizing the virtual office equipment. Others in the network would then be able to "visit" the virtual office through the computer network, have meetings via the audio and video connections, while also consulting documents in the virtual filing cabinet or illustrating ideas on the virtual whiteboard, etc. When an office holder is out, a "visitor" could leave messages on the whiteboard, get documents from the filing cabinet. if permitted by the office holder, etc. (The "virtual" elements of such gadgets constitute a particularly provocative example of technological artifacts as "prosthetic.")

The team leader decided early on that the application should be designed to be as flexible as possible. His idea was that each end-user could in turn design a virtual office that would fit his or her individual needs and style. I spoke at length with him concerning this, and quickly learned that he was passionate about this flexibility. He gave maximization of flexibility as a reason for the team's design choices at various levels of the application. When we first discussed this, he gave examples from what may be the most obvious elements of the interface, such as whether or not to have a virtual whiteboard, where to locate it, and deciding who could have access to it. But as we discussed this further, he took the matter of flexibility down

to the level of the architecture of the software and even in a couple of cases to writing the software code. During the discussion, I asked him in various ways why flexibility was so important to him. Repeatedly, he indicated that he was committed to "empowering the user." Toward the end of the conversation, he began to justify flexibility for the user in terms of workplace democracy. Ultimately, flexibility, user empowerment and workplace democracy emerged, to my mind, as values that guided his work—in fact, values of a moral character. He and his team literally built these values into the technology (for a similar point, see Winner, 1986). I mean "literally" in that one could not explain why the application had certain characteristics that it did without reference to those values.

When it was initially ready, the virtual office application was tested by installing it on the computers of a group of administrative staff in the lab. Although the "admins" had been eager to be part of the test, once the application was installed, they made little use of it. In fact, they hardly configured their virtual offices at all, and when they did, their designs were far simpler than what the system was capable of. Whatever else this may have indicated, it meant that the admins took almost no advantage of the flexibility that the project team had worked so hard and passionately to put into the design of the system. At this stage, the application looked like a potential failure.

During the test, I talked with some members of the admin staff about the application. When I asked them about the test and what they had done, or not done, in configuring their virtual offices, they said that they couldn't make much sense out of it and that they felt "abandoned." From their perspective, the project team came in, installed the application and went away. The admin staff had wanted more guidance and help from the design team. In further discussions with the admin staff, it became clear to me that among the things that were valuable to them about their work were feeling included and supported.

This, it seemed to me, was a source of the problem. The virtual office application, as an artifactual system, had the values of the design team built into it. But the design team and the admin staff, as human systems, had different values infrastructures. Flexibility for the user as envisioned by the design team, clashed with the admin staff wanting to feel supported. Consequently, what was intended as democratic empowerment was taken as abandonment. So, the problem encountered in testing the application's initial design was not technological so much as it was axiological. In untangling the problem, reconfiguring the functions of the application alone would not very likely address the situation because the criteria against which it was designed in the first place were not functions but values. Since the problem rested with the clashing values infrastructures of the two interconnected human systems, it is there that criteria for a fix were to be found. It was important, I felt, to deal with the clash of values at the level of the human systems. This, in fact, surfaced when the two groups began to talk with one another about the lackluster test. The admins came to understand that the developers had intended the flexibility to put more power in their hands, even though it ended up being technically more than they were comfortable with. The value that the admin staff placed on being supported in dealing with new workplace technologies, meanwhile, came to the attention of the

project team leader. The design team was then in a better position to plan the next phase of the project to include more follow-through support for the admin staff while still incorporating a good measure of flexibility into the design of the application.

The virtual office application can be seen as a socio-technical system. It was conceived of as a technology to link together members of a social group, who in turn could configure the technology in keeping with their needs and styles. In the terms of the broadened perspective on socio-technical systems presented here, the application was an artifactual system that was designed to afford various functions of the human system that would use it. As an artifactual system, its design could not be explained solely in terms of the technical functions it was to serve, but also required reference to the values of its designers. To be useful, to flourish, the application also needed to be configured by the users in ways that would be stable enough to afford the desired social functions, thus enabling them to flourish as a "virtual" group, and to do so in a sustained and sustainable way. The test failed because the admin group made little use of the application's flexibility. This was due to a mismatch between the values infrastructure of the designers, as built into the application, and that of the users. So both the original design of the application as a technological artifact and its failure to afford the intended social functions were rooted in the axiological dimensions of the two human systems.

4 Conclusion

Our lives are today are suspended within a complex network of systems, and increasingly dependent upon their sustenance and stability. This network contains three kinds of systems, natural, artifactual, and human, that are as distinct as they are interdependent. Artifactual and human systems, from economies to cities to organizations to the latest technologies, are products of human design. They embody, by choice or default, our axiological judgments about what is worth doing and how best to do it. If the systems we make are to afford patterns of human life in any way we ought to find acceptable, and reflect the fact that everything we may make is ultimately dependent upon the flourishing of nature, we must make deliberate values assessment a much more explicit element of how and what we design.

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