Some Comments about Technology and "Repurposing" from a historian and an anthropologist – for the Sante Fe Institute, July 2008

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The remarks below are responses to the workshop prospectus entitled "Principles of Repurposing," written collaboratively by a historian and anthropologist, each of whom has been engaged deeply for many years with understanding processes of technological change. We have ourselves never framed these processes as "repurposing," and, as will be evident below, are not fully comfortable with the term. Nonetheless, the issues raised in the prospectus are genuinely interesting to us and we believe our experience may be of some value to workshop participants, even though we cannot ourselves attend.

The prospectus introduces the notion of repurposing to contrast problem solving with "a completely novel set of specialized tools[1]," so that problems are seen as solved "by modifying and combining preexisting tools." Our study of technology suggests that inventions never consist of "a completely novel set of specialized tools," but are always based on

[1] The word "tool" is adopted here to be consistent with the conference prospectus, but the relationship between "tools" and "technologies" is historically more complicated that our usage here suggests. In fact, these comments (as well as much of the discussion in the conference prospectus) are largely about technologies in the broader sense. If conference participants want to talk more narrowly about tools, this has implications for the generalizations that may emerge. The distinction between tool and technology is not, however, particularly significant for the remarks we make here.

the modification and combination of known devices or techniques. From this perspective, technological innovations may be characterized in one or more of the following ways:

(1) A tool is put to a new use, with no substantive modification

(2) A tool is altered to adapt it to a new use

(3) A tool is altered to improve performance in an older use

(4) A tool is made explicitly more versatile by addition or alteration

(5) A tool is made by combining elements of tools designed with similar uses in mind

(6) A tool is made by combining elements of tools designed with very different uses in mind

All tools – and even many "naturefacts" that are not of human origin, but have human uses – can be modified (or "repurposed") for new uses. All uses of natural objects and materials would appear to qualify as "repurposing," so long as we assume that an original "purpose" was defined by evolutionary-ecological contingencies.

The question, at least for technology, would appear to be one of design – what aspects of a tool's design are most closely related to the flexibility of use? History suggests that this will be a very difficult question on which to generalize. Nonetheless, there are some interesting examples. The so-called chipped-stone "handaxe" of the Lower and Middle

Paleolithic was once believed to be a single-purpose tool, used in hacking at animal carcasses. However, microscopic examination of the working edges of handaxes revealed that they were used in a variety of tasks on a variety of materials. Moreover, they were also a portable source of raw material because flakes could be easily struck off as needed. We are now apt to call the handaxe the Swiss Army knife of deep antiquity! In societies having high residential mobility, as in most hunter-gatherers groups (from the Paleolithic to the present), a premium is placed on the design of tools that are flexible in use—i.e., multifunctional--because of limitations on what people can carry from camp to camp. Subtractive technologies like chipped stone—where material is removed to produce desired forms--lend themselves to a variety of reuse processes. For example, a projectile point with a broken tip can be easily rechipped (i.e., recycled) into a scraper or spokeshave.

Some artifacts pass through predictable stages, involving different uses, during their life histories. As use continues in one activity, accumulated wear and deterioration make continued use of the artifact in that activity difficult because of altered performance characteristics. Nonetheless, the altered performance characteristics render the artifact suitable for a second activity, and so on. This is a very common process. A suitable example comes from the Fulani of the Cameroon: a house becomes unsuitable for habitation and becomes a storeroom; after some period of use as a storeroom, further deterioration makes even that *activity difficult, and so it is used as an animal pen. Even ceramic vessels can go through sequential stages of use, as in cooking, storage, and roasting. However, it is doubtful that any of these sorts of artifacts were designed with expectations of particular reuses in mind.*

A different general process is at work when the sherds of a vessel are reused. In that case, the sherds are treated as a raw material—i.e., artificial stone—and are chipped and/or ground to make other artifacts, such as scoops, gaming pieces, spindle whorls, and scrapers. Further, in some societies, sherds are thoroughly ground up and added to clay as a nonplastic material that confers several advantageous performance characteristics on the clay and on the vessel itself during firing and use (as a cooking pot).

Objects made of metal and glass and certain polymers, if of homogeneous composition, readily lend themselves to recycling, and shaping into myriad new objects. Thus, if I were interested in designing new products whose components could be recycled, I would use such materials and be certain that, in composite objects, the components could be easily separated. This is not a novel notion! The problem is that the life histories of products in industrial societies, especially, are embedded in complex social networks (these networks have been called "cadenas," from the Spanish word for chain, relating to the fact that the activities in an artifact's life history can be modeled as existing along a "behavioral chain"). The designers, manufacturers, users, and reusers of *an object are likely to be different individuals or groups, each with their own performance preferences for the artifact. Needless to say, these preferences can be at odds. For example, manufacturability and low cost are often of interest to the manufacturer, whereas recyclability is of interest to the reuser (or perhaps user). Thus, what incentive does a manufacturer have to use recyclable components if those products are recycled by other groups? That is one of the difficulties of designing-in flexibility or reusability in the products of an industrial society.*

During the 1970s, "adaptive reuse" was recommended for old structures. In European nations, this kind of reuse was common, but it became an architectural fad in the U.S., witness loft condos and apartments in old factories and warehouses, restaurants in old train stations, and so on. Adaptive reuse would appear to be highly opportunistic, depending heavily on the resources of developers or government agencies and on location and anticipated occupants.

A second question for technology concerns the role of the user, implied in the some of the examples above. The user, as bricoleur, regards all objects as potentially capable of being put to new uses as contingencies demand (or merely suggest). Thus, in the material culture inventory of a household, we are apt to find—if we make careful observations on the objects themselves—many items that show evidence of uses not intended by the designer. Think, for example, of screwdrivers showing traces of paint, indicating that they probably were *used to open paint cans, or evidence of pounding on the handle, suggesting they had been used as chisels or pry bars*

For the concept of repurposing to have any real use, its relationship to these notions of recycling and reuse needs to be made clear. Behavioral archaeologists, for example, have noted that patterns of reuse can be linked to social and personal factors, such as wealth and the stage of household development. It is particularly important to take into account the roles not only of makers but of users in understanding the purposes to which technologies are put. The flexibility of use is often not associated at all with the intentions of the designers, and the historical evidence does not suggest that final uses (not to mention effects) are typically well-predicted from initial purposes. To further complicate matters, designers, makers, and users are not the only actors to be accounted for. Other agents—entrepreneurs, promoters, journalists, regulators, and the like—are often active shapers (and re-shapers) of how tools are used. The story of repurposing in many technological systems is a story of the interaction of these different actors as they "negotiate" both how a system or component is designed and how it is used. This negotiation typically goes through different stages (although in a variety of patterns and sequences) in which different actors have different levels of influence on the outcome, perhaps related in part to relative social power. It is further important to realize that the negotiating process is one that frequently does not *end, at least not until the technology or its system has passed from use entirely and enters the archaeological record. In other words, the social, economic, and political environments in which technologies function constantly change, and thus "purposes" (or, perhaps more aptly, "uses") are constantly subject to change as well.*

The reference to environments suggests also some of the complications involved in talking about "technological evolution." There is little historical evidence that the rates of technological change, either in broad terms or within the context of specific industries, are closely correlated with design flexibility. Indeed, there are in technologies (as in biological evolution) important factors at work that promote change while at the same time they apparently reduce flexibility. One way to understand this is by taking into account two key factors that shape change: incumbency and contingency (to use the terms adopted by economic historian Paul A. David). Incumbency refers to the fact that a condition or feature tends to persist unless dislodged. Contingency simply involves the unpredictability of influencing events. These two notions turn out to be remarkably useful in accounting for both the rate and the direction of technological change.

For the purposes of this discussion, the significance of incumbency is simply that designs tend to retain features even as artifacts and systems are "repurposed," even if those features lose their utility (or, even more interestingly, even if those features change their utility in *unanticipated ways). This sort of thing is found in biological evolution all over the place, but it is found in technology as well – perhaps the QWERTY keyboard is the most readily apparent example. It is important to understand that designers incorporate this principle all the time. When a computer program is written, for example, it is rarely (unless it is trivially simple) written from scratch, but is typically the adaptation of an older program. This is rational and economical, since the debugging of computer code is a significant cost in writing a program – recycle ("repurpose"?) old computer code as much as possible to reduce this cost.*

The importance of contingency becomes clear when the results of this kind of recycling/repurposing are confronted. In the case of computer coding, for example, the Y2K problem confronted a decade ago came from the contingency of the steps taken to reduce data fields in the early days of computing (due to the high costs of memory and processing). The incumbency of the result – which included date fields that did not take century changes into account – was the basis for the Y2K situation. It is important to understand that there was nothing "irrational" or "inefficient" about the original design decisions, despite the expensive consequences decades later.

These kinds of historical cases, however, raise questions about the effort to identify "archetypal repurposing structures," at least for technologies. <u>Any</u> technological design may (and probably will, if it is at *all successful) be repurposed, in the sense introduced here. But the nature of the repurposing, the significant contingent and incumbent structures, and the distance and direction of change involved are all fundamentally unpredictable, in large part because these are as much social, economic, and political matters as much as technical ones.*