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VALUES IN TECHNICAL DESIGN

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Although their precise parameters and significance are easily debated, it is generally recognized that values influence the design of scientific experiments. Because scientific research is designed to yield answers to specific questions, truth values in operational forms internal to science play prominent roles in the structuring of research activities. Moreover, when experimentation takes place with human subjects or dangerous reagents there are further values of respect for persons and public safety that readily take the stage. It is thus not difficult to argue that values regularly and properly are embodied in scientific activities—and that the practice of science can have value implications for the larger social contexts in which they are pursued.

The idea that values may also be embodied in engineered products, processes, and systems is perhaps more controversial, although the thesis is now commonly argued in a variety of disciplines relevant to questions of science, technology, and ethics (e.g., Winner 1986, MacKenzie and Wajcman 1999). Moreover, a practical turn from what has sometime been a largely descriptive posture sets forth values as a design aspiration, exhorting engineers, producers, and consumers to include values in the criteria by which technological excellence is judged (Mitcham 1995). For those committed to bringing selected values to bear in technical design, the ideal result is a world of artifacts that embody not only such instrumental values as effectiveness, efficiency, safety, reliability, and ease of use, but promote (or at least do not undermine) substantive values to which the surrounding societies or cultures subscribe. In liberal democracies, such values may include, among others, liberty, justice, privacy, security, friendship, comfort, trust, autonomy, and transparency.

But it is one thing to subscribe to such ideals and another to put them into practice. Putting values into practice is often dismissed as a form of political or moral activism irrelevant to the designing of technical systems such as software programs. Experienced software engineers will recall the not too distant past when interface and usability were also overlooked features of software system design (Adler and Winograd 1992). While these and other aspects of design have now entered the mainstream, we are still at the shaky beginnings of thinking systematically about the practice of technical design and values (Norman 2002). Even designers who support the principle of integrating values into systems are likely to have trouble applying standard design methodologies, honed for the purpose of meeting functional requirements, to the unfamiliar turf of values. There are at least two factors that contribute to the difficulty of embodying values in the design of technical systems and devices—one epistemological, the other practical.

Epistemological Challenges

One reason the study of human or social dimensions of technology is so demanding is that the areas of knowledge and relevant methodologies are far-flung and self-contained. This dispersion is reflected in the disciplinary organization of universities, in which science and technology are typically segregated from the social sciences and humanities. Yet the successful embodying of values in technical design demands simultaneous engagement with these distinct areas of knowledge and their respective methodologies. For technical design purposes, what is readily drawn from these fields is sufficient, whereas for others the puzzles raised push beyond standard boundaries. Either case, however, calls for more comprehensive interactions among diverse areas of knowledge than is customary—in the first instance requiring enough knowledge to identify existing, relevant insights; in the second, deliberate efforts to extend what is known in order to address the hard and sometimes novel questions that arise.

In practical terms, these active interdependencies may be understood through the metaphor of "balls in the air." Conscientious designers must juggle and keep in play the results of at least three modes of knowledge: foremost those from the relevant scientific and technical fields; beyond these, philosophical reflections on relevant values; and finally empirical findings regarding relations between values, individuals, and their societies. The balls in play metaphor reflects the need to direct attention to all three aspects simultaneously, keeping an eye not only on each factor but also on how the three factors shift in relation to each other.

H. Nissenbaum, "Values in Technical Design," *Encyclopedia of Science Technology and Ethics* New York: MacMillan, 2005, lxvi-lxx

TECHNICAL MODES. In the technical mode, a designer or design team brings to bear state-of-the-art scientific knowledge and technical know-how on particular design specifications that realize given values in an overarching design project. In a project to build a hospital patients record system, for example, designers might be charged with the task of building privacy protection into the software. In responding to this charge, they might aim for a design that enables access to particular fields of data only by specific, authorized members of the hospital staff. With this goal in mind, they set about designing system constraints, and selecting or creating mechanisms to attain them.

These steps, comprising the technical ball-in-play, are familiar to technical system designers. The sole departure in the present instance is that they are described as undertaken in the name of values and not, as is typically the case, in the name of technical functionality and efficiency.

PHILOSOPHICAL MODE. While designers and engineers seek and invent mechanisms to meet design specifications for promoting values, the philosophical perspective is generally overlooked. But values are more than simple givens. Values can themselves be examined in terms of their origins and scope of relevance, their meanings, and as the basis for normative influence—especially when it is necessary to resolve conflicts.

At the foundation of such philosophical reflection lies an account values that may be quite contentious. There are extensive debates about the precise character of values, for instance, whether they are subjective or objective. Nevertheless, within a broad construction of values as interests, purposes, or ends in view, those of greatest concern in the present context are values that can be construed as social, moral, or political. This still wide-ranging category includes abstractly conceived values such as freedom, autonomy, equality, justice, and privacy, as well as concrete values such as friendship, safety, sociality, and comfort.

The question of whether any such values are universal to all humans or are always locally defined by nations, societies, cultures, religions, communities, or families deserves to be appreciated for its moderating influence. Designers and developers of technology in the United States (and other technology producing liberal democracies) may confidently reach for constitutional values such as freedoms of speech, association, and religion; protections of property, equality, due process, and privacy; or cultural values such as individualism and creativity. But they should at the very least also consider whether such values are always appropriate to other countries where their products may be distributed. At the same time, taking the Universal Declaration of Human Rights as a guide, it is reasonable to postulate a few basic values as common to all humanity, with specific interpretations subject to local variation—a position that nevertheless remains subject to philosophical analysis and empirical assessment.

In seeking to promote the embodying of values in technologies it is a designer's understanding that will guide how they are "cashed out" as system features. In the case of the electronic patient records example, concerned developers seek specifications that will yield privacy and not something else, and a key factor will be defining privacy. Evaluating the proposal mentioned earlier to operationalize privacy by giving variable access to the different fields of information, a philosophical critic might argue that a different interpretation of privacy would support a system whose default is to give access to the patient only, as a way to embody privacy as control over information about oneself.

An ability to consider and discuss such alternatives is a significant component of what it takes to keep the philosophical ball in play. In some instances this means turning for insights to a long tradition of philosophical and political thought that guides the moral and political systems of the different technology producing liberal democracies. Because many of the most important and contested value concepts have evolved within these traditions, design teams might need to plumb them for sound, workable concepts. Failure to take these concepts seriously can lead to bungled interpretations in the specification of design features.

Two caveats: First, it is unrealistic to expect designers always to work from first principles and grapple directly with abstract conceptions of value. Yet over time, one can imagine an emerging database of analyses specifically developed for the context of technology design. Second, traditional analyses may not be sufficient when technology itself has brought about such radical change in the social and material world that certain values themselves demand reconsideration. In such cases, as with privacy in the wake of information technologies, keeping the philosophical ball-in-play means producing original research analyzing on the concepts at issue.

Finally, the philosophical mode engages with issue of normative force, providing rationale or justification for commitments to particular values in a given device or system. With the electronic patient record system, one might consider why privacy is relevant, important, or necessary. Frequently, the answers to such questions are to be found in surrounding moral and political theories that explain why and when certain values ought to be promoted. This is particularly needed when conflicts among values result from specific design choices. Normative theory can guide resolution or tradeoffs. In the patient records system, finding that access is slowed as a result of privacy constraints, designers might return to the underlying theory of a right to privacy to learn the circumstances under which privacy claims may justifiably be diminished or overridden.

EMPIRICAL MODE. Empirical investigation answers questions that are as important to the goal of embodying values in design as the philosophical and technical. Not only does it complement philosophical inquiry into what values are relevant to a given project, but it is the primary means for addressing, systematically, the question of whether a given attempt at embodying values "worked"—that is, whether the intentions of designers were fulfilled.

Philosophical inquiry can take us only so far in determining the values that ought to be considered in relation to given technological projects. Even if one holds to the existence of a basic set of universal human values, the people affected by these projects are likely to subscribe to a far richer set of values determined by their cultural, historical, national, ethnic, and religious affiliations. It may be even more crucial to attend to these commitments when engineers face choices among design alternatives. Despite the enormous attention philosophers, and others, have given to the problem of systematically resolving values (and rights) conflicts, this remains notoriously difficult. For such situations, ascertaining the preferences of affected parties is a sound practical response, using such methods as surveys, interviews, testing under controlled conditions, and observation in the field. In the conflict between efficient access to information and its confidentiality in a patient records system, for instance, designers should at least consult preferences among affected parties.

Empirical investigation is also necessary for ascertaining whether a particular design embodies intended values. Again in the case of the electronic patient records system, designers might learn from observing patterns of usage if security mechanisms for restricting access to the appropriately authorized personnel are so onerous that many users simply bypass them, thus leaving the records more vulnerable than ever. They might thus discover that their attempts to promote privacy are thwarted by a design that does not achieve its intended results—information crucial to any values in technical design analysis.

VALUES IN PLAY. The metaphor of balls-in-play includes not simply the need to incorporate three distinct modes of knowing into the design context but an effort to iteratively integrate these modes. Because findings from each of the areas affect or feed back into others, members of a design team cannot seek solutions in each area independently. Although the hardest cases might call for innovation within each of the three modes (and hence diverse expertise), many cases will be able to rely on what is already known in at least one or two.

Consider, for example, the task of building a system that provides fair access to information to diverse members of a community. Designers might quickly settle on accessibility to all mentally able individuals as the embodiment of the value of fairness, while it struggles with the technical questions of how to go about doing so and, later, testing empirically whether particular designs have succeeded. It is reasonable, furthermore, to hope that with greater attention to the study of values in technology a body of findings, experience, results, and definitions will develop that gradually will alleviate some of the epistemological burdens.

Practical Challenges

In addition to epistemological challenges, the practical challenge engineers face is the sparseness of methodologies for embodying values in system design, due in part to the newness of the endeavor. If we think of what we need to know constitutes the ingredients for a recipe, then what remains is the equally important method for combining them into a dish. Attempts to fill this methodological gap are new and evolving. Some that have been around longer are restricted to certain specialized areas of application.

One of the best known in the latter category is an approach known as "participatory design." Having evolved in Scandinavia, in the context of the workplace, the methodology is committed to democratic participation by those likely to be affected by new technologies as well as design outcomes that enhance not only efficiency of production and quality of product but the skill and well-being of workers. Emerging methods include value sensitive design, which recognizes the importance of technical, conceptual, and empirical investigations to the purpose of bringing values to bear in the design of information technologies generally. Another approach developed by Mary Flanagan, Daniel lowe, and Helen Nissenbaum (2006) posits a methodology comprising four constitutive activities for embodying values in design—discovery, translation, resolution, and verification—which, in order to illustrate possibilities, can be considered here.

DISCOVERY. The activity of discovery involves identifying values that are relevant to or might inform a particular design project by looking to key sources of values in the context of technical design and asking what values they bring to the project in question. The specific list of values will vary considerably from project to project. But one promising heuristic is simply to ask "What values are involved here?" and then brainstorm possible answers. Sometimes values are expressed explicitly in the functional definition of a deliverable (as grasped through the technical mode of knowing). But all designs are underdetermined by explicit functional requirements, leaving designers and developers numerous alternatives as they proceed through an iterative design process.

Open-endedness calls forth the implicit values of designers themselves (and thus may be furthered by the philosophical mode of reflection). Sometimes designers unconsciously assume that they are the likely users of their work and act accordingly. But values reflection in technical design can almost always be deepened by efforts to critically identify implicit values in both designers and potential users (as accessed by means of the empirical mode of inquiry), and subsequent critical assessments of and dialogue between such values.

TRANSLATION. In the activity of translation, a design team operationalizes value concepts and implements them in design. The values discovered in the first moment of reflection are not only multiple but they tend to be abstract. To become concretely accessible in the design context they will need to be rendered into operational or functional forms. This translation activity will almost certainly involve some input from the philosophical mode of knowing. No matter how well value concepts are operationalized, the efforts of conscientious designers are easily undermined if the historical traditions and substantive characteristics of particular values are incorrectly interpreted. With values such as privacy, for example, clarity, good intentions, and technical competence can be misdirected when not adequately backed up with sensitive analyses of various philosophical approaches to privacy itself.

RESOLUTION. Translation is key to any implementation of discovered values. But implementation and the corresponding transfer of values into design specifications also calls for the resolution of any potential incompatibilities in a values possibility space. One of the major challenges of implementation is resolving conflicts that arise as a result of specific design choices.

Conflicts arise when designers who have committed to some set of discovered values, further discover that it is practically impossible to embody all of them equally well within some product, process, or system. Engineering is rife with such conflicts: whether to favor safety over cost, transparency over privacy, aesthetics over functionality, with many more appearing at layers of finer granularity. Resolving such conflicts is by no means a challenge for engineering alone, but is manifest as one of the enduring problems of practical ethics, politics, and law. But this means again that the resources of the philosophical mode of thinking may be of special benefit to this moment in practical values design work.

VERIFICATION. Finally, the activity of verification involves assessing whether values have been successfully embodied in design. Verifying the inclusion of values is likely to draw on both technical and empirical thinking. It can easily begin with internal testing by the design team but will not be complete without user testing in controlled environments.

It might be useful in this regard to consider the possibility of some approach analogous to that of clinical trials for pharmaceuticals. In phase one trials the basic question concerns whether a drug is safe. Phase one studies, which are short term, are done to gather preliminary data on chemical action and dosage using healthy volunteers, and there is no comparison with any control group. In phase two trials, which take longer, the basic question is whether the drug works to achieve a desired therapeutic end. Is it an effective treatment? Now the trials are done with patients who exhibit a target disease or illness, and there are control groups for comparison. Finally, phase three trials focus on the long-term effects in larger populations. Only after this phase is complete may a drug be widely marketed. In a like manner one might construct a series of alpha, beta, and gamma testings of new technologies to assess how values may have been embodied in technical designs, using initially small groups of technical volunteers, then non-technical users with the need that a new technology aims to address, and finally longer-term monitoring of larger populations of consumers and users.

Open Questions

It is too early to judge the long-term success of any method for embodying values in technical design, because few projects have proceeded through the various milestones characteristic of the lifespan of technologies—including, sometimes, unintended (often negative) consequences. The method nevertheless deserves serious consideration in any discussion of science, technology, and ethics—not only in relation to the kind of case referenced here (that is, software design) but across the technology spectrum, from machines and structures to systems and software. Moreover, critical consideration may also throw light on the roles of values in design of scientific experimentation.

Two other potentially critical stances are worth mentioning. Taking a social constructivist stance, critics might question the supposition that key social, ethical, and political aspects of technologies are attributable either to their blueprints or physical shape. What imbues technologies with values are not any of their objective functions but their meanings, generated by the interpretive forces of history, culture, politics, and a myriad other social contingencies. An ironically related stance holds that technologies are neutral. The extent to which systems or devices promote values is a function of the individual uses to which they are put; technologies are mere tools of human intention. Although the view of technology as neutral is currently out of favor in scholarly circles, it remains a common presumption with which those interested in values in technical design must contend.

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