Design in Engineering and Architecture

Towards an Integrated Philosophical Understanding

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1 Introduction

The present collection of essays provides an overview of current work by philosophers and ethicists on the design process and its products. We have collected a group of essays on topics which are not usually considered together. The volume contains essays on engineering and architecture, focusing on a broad spectrum of items, ranging from cars to software, from nano-particles to cities, and from buildings to human beings. As such the volume trades on the ambiguous meaning inherent in the general term "design" which we will consider in the broadest sense of "changing existing situations into preferred ones."[1] By bringing these diverse essays together, current thinking about design can be presented in all its facets, permitting us to consider the broad category of design, despite its different meanings, as an activity with a common root.

One of the conclusions which can be gleaned from these essays is that new developments in engineering allow for a more integrated understanding of engineering and architectural design, two areas of design which may have been thought to be too far apart to be comparable. But in these chapters engineering is presented as an activity that is not merely concerned with composing material products. Due to the emergence of new technological capabilities and the growth in demands that society puts on the implementations of technology, engineers are forced to consider how the material products they create interact with human agents. For philosophers and ethicists this is a familiar observation. Philosophy of technology, emerging after World War II as an independent field, first concerned with the social impacts of technology, and now more robustly directed toward the

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[1] Simon (1972, 55).

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empirical dimensions of the metaphysics and epistemology of specific technologies, has always been focused on the ways in which technology shapes individual human lives and a range of social institutions.[2] This focus has now been extended to the analysis of engineering design itself. Engineering design is identified as a process in which technologies materialize into products, and thus as a process that substantively shapes and reshapes our lives and our societies. The essays in this volume on engineering design in the classical "nuts-and-bolts" sense provide more examples of this phenomenon. In the essays on design in the new emerging technologies, this focus on shaping lives and society becomes even more visible. To take just one example, the convergence of informatics and genetic engineering raise questions not only about the relationship of humans to each other but also about our understanding of what it means to be human.

If these developments of emerging technologies reveal thoroughgoing moral and social dimensions of engineering in general, what follows? No doubt, many things. We will focus here on how these developments push a more robust description of engineering design toward a more accepted description of architectural design. If the gap between these two forms of design can be bridged, then we are on our way to an understanding of a more integrated philosophy of design.

To help to frame the discussion which follows, take for example the growing interest in the design of *socio-technical systems*. Even older forms of these systems, such as the electrical power grid, consisted of material hardware and human agents as an integrated component for the operation of that hardware. Though more recent developments such as cellular telephone networks may not yet represent a difference in kind of system from these older systems, they certainly compound the social dimensions of those systems to an impressive degree.[3] We would argue that a fully responsible design of such systems necessarily requires engineers to pay attention to the human agents and to the social institutions they inhabit, inclusive of technical manuals, company regulations, national or international law, and the larger framework of social capital implied by the production of such systems. The interest of engineers in designing these complexes of hardware and social institutions bring us to architecture. Our contention is that the growing complexity of engineering design reduces the distinction between it and design in architecture. Architects that design our buildings and living environments have been consciously influencing the interaction and social organization of human beings at least since the late 19th century. Their works, and the history of their enterprises, are thus immediately relevant to engineering as it is developing today. In that context this volume seeks to provide an overview of current philosophical and ethical work on design by bridging the literature on design in engineering and architecture. It also provides the means to help practitioners and

[2] See for example several recent anthologies which have come out on philosophy of technology including, Kaplan (2004), Katz, Light, and Thompson (2003), and Scharff and Dusek (2002). A thorough history of philosophy of technology is found in Mitcham (1994). For the recent analytic turn in philosophy of technology see Pitt (2000), Baird (2004), and Kroes and Meijers (2006).

[3] Biometric markers in cell phones may greatly magnify the social dimensions of these systems to create a difference in kind from older technologies. See McGee (2003).

philosophers come to a more integrated understanding of the phenomenon of design. Despite its diverse manifestations in engineering and architecture all design can increasingly be seen as aimed at the same goal: production of our material environment and the way in which we are designed to live in that environment. In the next two sections we will defend this proposition more fully.

2 Engineering and Architecture

Our promise to provide an integrated understanding of the philosophy and ethics of engineering and architectural design trades in part on the current view that these two practices are quite different. Articulating this view and analyzing the nature of the assumed differences is complicated by the fact that there are competing accounts of how these differences arose. As with any historical relationship, contemporary practitioners of both disciplines tell different stories of their estrangement. But professional affiliation is not the only filter of history. In this section we will briefly outline two competing narratives that are thought to separate these two disciplines through differing attitudes toward authorship and organizational structure. What we offer is far from comprehensive but should help to understand better how engineers and architects have positioned themselves within the societies they serve.

2.1 The Dominant Narrative

It is often assumed that engineering and architecture share some conditions of practice but remain inherently different in nature. On this view, engineers make things that work and architects order space, giving visual expression to the built environment. What is common is that both engineers and architects design for material production by others, in response to assignments originating from a third party. Particularly in large projects the third party, or "client," is actually a collection of parties with distinct interests, owners, users, and those who finance, regulate, or insure the products created. However, whether designing large or small artifacts, engineers and architects typically produce designs to meet the goals and requirements of that third party. Unlike fine artists, who generally initiate works in isolation from surrounding social and economic conditions, architects and engineers rarely do so.

As there are disciplinary similarities, so there are clear differences. Obvious differences concern the products designed and, consequently, the types of knowledge involved in production. Engineers typically design things such as consumer goods, machinery, public utilities, and other useful products. Architects design the buildings we live and work in and the public environments created by these buildings. Another marked difference, which we will initially focus on here, is how authorship in engineering and architecture is understood.

In the traditional view architects are taken to be the authors of the products they design. Even when architects, as they must, meet the goals and requirements set by those who commission them, there is ample interpretive flexibility within the design problem for them to create unique spatial and material compositions. Clients generally expect such an expansive interpretation of the stated design problem. Under certain circumstances buildings and landscapes are commissioned to reflect the architect's personal style and vision as evidenced in prior work. In this context architecture is perceived to be similar to the fine arts. Building owners may seek to enhance their own social position through association with the artistic authority of the architect. Such an understanding of the social context of architectural production is aided by a traditional philosophy of art whereby paintings, sculptures, or other products are designated by a single author. To the philosopher of technology, however, a single author of an architectural product may seem naïve. The client, let alone the many draftsmen, engineers, suppliers, and contractors who contribute skill and knowledge to a project's realization, also contribute to the design process. But whether one prefers the lens of single or multiple authors, the traditional view tempts us toward a vision of the architect as author, either producing a unique vision alone or directing a panoply of other actors assisting in the production of that vision. Such a view may also beg the question of whether architects are responsible for the consequences of their designs in a more substantive way, but this is an issue we will take up later.

Engineers are traditionally viewed as operating in a less publicly recognizable manner. The products they design are characterized by the technological possibilities of their era, and may include decorations peculiar to their period, but nonetheless engineers are typically more anonymous as authors of their work. They may advise those that commission their work about adjusting their expectations, or bring to a project a specific method of designing. But their products are generally oriented by a reductive, rather than expansive, interpretation of the design problem at hand. This is to say that the specific goals and requirements agreed upon at the beginning of the design process tend to limit engineers to coming up with efficient technical solutions to problems. Some pioneering engineers may be known more publicly for their inventions, and countries may even have a few heroic engineers known for public works of national grandeur. But the average technical product will not be recognizable as designed by a particular engineer. A full explanation of the roots of this traditional difference between authorship in engineering and architecture is complex, but we can say here that, on the whole, engineers tend to interpret design problems reductively using quantitative criteria, and architects tend to interpret design problems expansively and to employ qualitative criteria.

A related phenomenon is that the cultures of engineering and architecture have produced different organizational structures that reflect differing values. Architects typically work within firms that are recognizable as architectural firms. This also holds for some engineers, but engineering has also been integrated into larger commercial enterprises that subsume the identity of engineers into the company's identity. Under such conditions large companies have taken over the role of authors of the products designed, such is the case with consumer goods like cars, cellular phones, and sports wear. The relative anonymity of the engineer is related both to the issue of authorship and organizational structure. If one accepts the notion that engineering is an objective science applied to specific problems, then authorship is concealed. The contribution of the individual designer is suppressed. In this context engineering has been defined as a profession that designs products that meet the goals and requirements agreed upon by those who commission them and nothing more.

Unlike architects, who tend to expand the scope of their design problems to go beyond the everyday, engineers tend to reduce the scope of their design problems to the narrowest possible empirical criteria. This is to say that engineers and architects have intentionally or unintentionally produced distinct "epistemic communities," or attitudes toward what can be known or designed.[4] An example of this phenomenon would be the traffic engineer who expertly designs a street intersection to meet the required flows of automobiles but does not consider the consequences of the design for pedestrians, the natural environment, or urban development patterns because these variables were not specified in the design brief. Engineers are encouraged to become designers that loyally and efficiently carry out the tasks they are set by clients, transferring not only the authorship to the client but also, in the eyes of the engineers themselves, the moral responsibility for the existence and use of what is produced for their employers.[5] In contrast, architects would be far more comfortable with expanding the stated design problem to include these other normative variables because they would be rewarded by their professional culture, if not the client, for doing so.

In part because engineers appear to be more in the position of taking orders rather than assuming authorship, philosophers who work on the ethics of engineering have developed a specific literature justifying "whistle blowing" by engineers. In part this literature attempts to justify standards of professional practice by engineers that can supersede obligations to their employers. Philosophers point to examples such as the explosion of the U.S. space shuttle Challenger as a relevant case. There it is argued that NASA engineers overlooked or ignored claims about design flaws in the "O rings," which sealed the joints between sections of the shuttle's solid rocket boosters, which caused the shuttle to explode on liftoff. Some argue that these engineers should have exercised a larger professional responsibility to protect human safety over the demands to fulfill a mission goal. Regardless of the merits of this claim, our point is that such arguments are thought to require special justification in part because of the limited understanding of the responsibilities of engineers prior to the development of this literature. This limited sense of professional responsibility in turn may extend from the constrained understanding of authorship in engineering as a whole.

In comparison, finding the political content and assessing responsibility for built space is relatively prosaic. For example, the architects of the early 20th century deliberately designed houses for the working class with small kitchens – e.g., Margarete Schütte-Lihotzky's *Frankfurter Küche* and Piet Zwart's Bruynzeel

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[4] Guy and Shove (2000, 35).

[5] Van de Poel (2001).

Kitchen – for separating cooking from living and for redefining it as a rationalized and technological activity of 'modern housewives.' Using a similar logic, many historians have argued that Georges Eugène baron Haussmann's boulevards for the new Paris of Louis Napoleon were designed to prevent its inhabitants from easily blocking off parts of their city during a riot. The same argument is made in reference to the design of new university campuses in the U.S. following the student unrest of the 1960s. As such, philosophers have not felt quite as compelled to articulate a unique claim about how architects should exercise some form of professional, moral, or social responsibility, but have simply pointed out the moral and social consequences of the products of architects.

In sum, this narrative grants expansive authorship and public responsibility to architects and relative anonymity to engineers. Our argument is that such reasoning is as much reflected in the evolution of differing organizational structures as determined by them. This version of the story, however, is deceptively simple. There is another way of looking at the relationship between engineering and architecture that adds satisfying complexity.

2.2 The Counter-Narrative

That architects take authorship for their projects, and accept responsibility for them, and that conversely engineers are more anonymous can be historically demonstrated. The problem is that history can also demonstrate the opposite. In the early "heroic" years of modern architecture (1920–30), for example, Ludwig Mies van der Rohe (first director of the *Bauhaus*) could argue with enthusiasm that "Architecture is the will of the age conceived in spatial terms."[6] Only a few years later his successor, Hannes Meyer, was even bolder in arguing that "building is the deliberate organization of the process of life."[7] There is little ambiguity in these statements, and many more like them by other modern architects that could be cited which, collectively, argue in favor of "architectural determinism," the claim that some kind of universal well-being and social justice might be achieved through design. Such determinism carried with it a strong sense of responsibility for the profession of architecture. If there was salvation to be achieved through design, then architects, both individually and collectively, were our redeemers.

But after fifty years of dashed modern aspirations, particularly in North America, the political optimism of the *Bauhaus* came under attack and was ultimately rejected by new generations of postmodern architects whose interests were limited to an apolitical vision of artistic practice that left questions of social and environmental responsibility to others.[8] To be clear, the political intentions of architects were never

[6] Van der Rohe (1990).

[7] Meyer (1990).

[8] Lang (1980). Also see, Larsen (1993).

as fully unified as many historians claim, nor did the architects of the 1970s, '80s and '90s swing *en mass* to limited visual concerns. Rather, a sober view of the state of architecture at the beginning of the 21st century reveals a pluralistic and diverse scene, one where some architects clearly practice as visual artists (these are the so-called "star-architects"), others practice in a corporate context much like engineers (these are technical production firms with names like SOM, RDGB, and BNIM), and a few have become more socially active and engaged than ever (these are firms that see themselves as socio-environmental activists).[9]

A deeper historical inquiry reveals even more about the current situation. Not only do architects and engineers practice in contexts that are increasingly similar, but modern architects have long admired the reductive qualities of engineering practice. For example, rather than distance architecture from engineering practice as many might expect, the early 20th century Swiss-French architect le Corbusier argued that "The Engineer's Aesthetic and Architecture are two things that march together and follow one from the other …"[10] From his perspective in 1920, le Corbusier saw engineering practice as a model of efficient production, devoid of neoclassical decoration and craft that previously denied the benefits of design-thinking to the masses. Embracing more modern and industrialized modes of production like engineers advocated would not only improve distributive justice but also result in an aesthetic that expressed such changed social values.

Although we tend to assume that building designs in general are the products of architects, they are the first to decry the fact that only two to three percent of housing (in North America) is designed by architects and many types of utilitarian buildings and infrastructure such as roads, bridges and harbors are designed by engineers. Observing the built world through the revealing statistics of the construction industry reveals that architects are far less the authors of the built world than we might think.

In sum, this counter-narrative suggests that it is a mistake to essentialize engineering or architecture. Attitudes and practices related to authorship and organizational structure within both disciplines are now, and always have been, in flux. Our argument is that across the range of practices and firms representing engineering and architecture we can see the two disciplines as increasingly more similar than distinct in relation to the societies that they serve. If one observes how contemporary engineers and architects actually work, we see that authorship and responsibility are more distributed in reality if not in the eyes of the public.

Without pushing on further with which of these two narratives is more accurate, our aim in this volume is to present a range of views on why current developments in engineering and architecture require the development of visions concerning the social responsibilities, ethical practice, and political context of both disciplines. In the past few decades more architects, engineers, and design methodologists have increasingly come to recognize what philosophers have been claiming for some

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[9] For example, see Bell (2004).

[10] Le Corbusier (1990).

time now, particularly with regard to engineering, that all design shapes social relations and hence contains an inherent moral and political content. It is to a more robust understanding of this common content that we now turn.

3 Shifting Boundaries

Let us return to engineering design, and to an analysis of its gradual development towards a model more like architectural design, as we identified it in the opening section of this introduction. In the 20th century the institutionalization of a rich variety of engineering design traditions and practices emerged. During the second half of the last century design practices gradually developed that focus on the material product of design and on the broader social system in which these products are supposed to perform their function. For example, with the advent of ergonomics, and the wide dissemination of computers, engineers became systematically involved in problems related to man-machine interactions and in designing human interfaces for their products. But the broadening of the boundaries of the systems that engineers had to deal with did not stop with the inclusion of human agents. Also, with regard to the life-cycle of designed objects, the boundary between products and users has been shifting. Calls for a more environmentally sustainable society, for example, has forced architects and engineers to consider products as items with life cycles that include their production and their disassembly. More recently, with the growing awareness of the vulnerability of large infrastructural systems to cascading failures and terrorist attacks, engineers have further enlarged their professional scope, to include in the systems they study and design, the interaction and social organization of human agents that operate massive technological products. This trend in different engineering fields has led to the emergence of systems engineering as a separate branch of engineering.[11] Originally this new field of engineering focused on the design of complex, large technological systems, and on the organization of technologically complex production processes, including complex design processes. Nowadays there is a growing awareness in this field that systems engineering will have to include human agents and social infrastructures as elements of the designed system.

As we pointed out at the start, design traditions have emerged that focus their attention on technological systems and what are called, by science, technology, and society scholars (STS), and philosophers of technology, socio-technical systems: amalgams of technological objects, agents, and social objects, all of which are necessary to guarantee the functioning of these systems. The crucial role of social infrastructures for the functioning of socio-technical systems may, for example, be illustrated by what happened to civic air transportation in 2001 just after the 9/11 attack on the New York City World Trade Center. The system of civic air transportation temporarily collapsed in part

[11] E.g., Blanchard and Fabrycky (1981) and Miser and Quade (1985).

because an element of its social infrastructure, the insurance of airplanes, stopped functioning. The material infrastructure of this socio-technical system remained in place but this was not sufficient to let it work successfully.

These developments in engineering can be characterized as ones in which the boundaries of the systems designed are no longer drawn solely around individual material products. Engineers must now enlarge their scope by recognizing wider boundaries, including human agents, their behavior, and ultimately their social institutions. As a result, engineers, like architects, are beginning to recognize their responsibility for the design of both material artifacts and the behavior of the agents interacting with those artifacts.

The notion of systems boundaries can also be used to capture an inverse development within architecture. What architects refer to as "building science" has transformed architectural practice in dramatic ways. New digital production techniques and new materials make possible architectural designs that could only be dreamt of a few years ago. In a way, architecture has narrowed its systems boundaries through a new emphasis upon building performance and the physical sciences. This is a development that brings parts of the architectural world much closer to engineering design. Here, as in traditional engineering design, design problems are approached primarily in a reductive, and not in an expansive way.

The turn by engineers from reductive to expansive design considerations produces a design practice which is more likely to resemble the moral and social consequences of architectural practices. Engineers working on socio-technical systems, like the architects of the working class' houses with their small kitchens, are in the business of consciously shaping the way people behave. This shaping of human behavior not only takes place with regard to man-machine interaction but, as argued above, social infrastructure. As molders of human behavior and interaction, engineers will have to think about the normative aspects of their choices on such structures. There they will encounter ethical and political dilemmas that are inherent in any consideration of human behavior. Moreover, the design of the material hardware and social infrastructure of a socio-technical system cannot be easily disentangled. The way in which the material products are technically designed produces constraints on the behavior of individual users and also requires the enactment of social institutions, such as building codes, regulations, and laws, to ensure that the system will function properly.[12] Engineering then becomes a deeply ethical and political practice.

Many design disciplines, other than systems engineering, must now recognize that design always has such social consequences, whether we choose to acknowledge them or not, and that these social consequences affect the success or failure of projects. The call to achieve environmental sustainability provides an illustrative example. Environmental degradation, most analysts now recognize, is as much a social problem as it is a technological one. The heating and cooling of urban buildings, which is linked to the "urban heat island effect," and rates of fossil fuel consumption,

[12] For a specific discussion on the historical development of building codes and their place within socio-technical systems, see Moore (2005).

are just two considerations. In the United States almost every building has its own heating and air-conditioning system. In contrast, many European cities have municipally owned “district” heating and cooling systems that significantly reduce emissions and improve fuel efficiency. The reasoning that lead to the production of such different systems are based, not upon engineering criteria as such, but on different traditions in different countries regarding property rights and the appropriate domain of public services. If the objective of technological development in this example is to successfully solve environmental problems, then designers must learn to think in new ways. In the design of socio-technical systems for environmental sustainability engineers must move, as in architectural practice, toward an expansive understanding of design problems. However, because of that move, engineers will have to confront the larger climate of social responsibility in which their design solutions will be developed and implemented. Some design solutions will be at odds with the broader social climate, and engineers like many architects today, become *de facto* social critics representing a substantial expansion of their professional responsibilities.

So as not to overstate our case, we must acknowledge that part of the expansion of responsibility will be a matter of choice. Many engineers will either ignore such considerations entirely and follow older expectations of the limits of design protocols and practices, or intentionally choose to do “business as usual” and refuse to push the boundaries of the social climate in which they have traditionally worked. Our point is that part of this expansion of responsibility will be imposed from outside by the sheer scale and complexity of the design problem at hand. To take a dramatic example, in the wake of the destruction of the city of New Orleans in 2005 after hurricane Katrina, how could it be possible to redesign the socio-technical system (which, in this case, was a city) without confronting the larger social and political climate that allowed for the growth and development of the city in the first place? One could, we imagine, simply rebuild the system of levies and canals to exactly their pre-Katrina state. But to do so would obviously be irresponsible, and given the likelihood of a similar climactic event in the future, a waste of public money. The engineering community could simply cede the decision on how and what to rebuild to politicians, differing responsibility for the success or failure of the effort to them. Clearly such a solution would also be irresponsible and irrational simply because politicians are not sufficiently trained in the relevant sciences. At some point engineers will either be called upon by politicians and city planners to describe what is possible in a rebuilding effort or else they will advocate certain solutions themselves. In that moment they can either choose to offer a design solution that accepts the goal of sustaining a city of a certain size on the New Orleans site or else reject it as imprudent or irresponsible. In either case, engineers will be implicated in a framework of responsibility for the future citizens of New Orleans whether they like it or not.

The emerging resemblance between the domains of design in engineering and architecture may be developed to a point where both may take advantage of the experiences and methods followed by the other discipline. We have three observations here.

3.1 Design Processes

Our first observation concerns the scope of the design process in architecture and its possible extension to engineering. Even in small projects various stakeholders are involved, some of which will be part of the socio-technical system being designed. One of the tasks of architects is to negotiate with these various stakeholders over the definition of the design problem and offer design solutions. It is seldom the case that one single stakeholder is in complete control of any project, that is, that there is a strict hierarchy between all the stakeholders involved so that the whole design process is steered from one command and control center. In traditional engineering design, focused on the design of technological hardware, these processes of negotiation play a much less dominant role.[13] The assumption is that the material products involved are purely technical in nature and are designed on the basis of the idea that their behavior may be controlled in all relevant aspects.

This is no longer the case for the design of socio-technical systems. If engineers recognize the social dimensions of their practice they may also be in a position to negotiate better among stakeholders on the parameters of individual design problems and the ethical and social dimensions of these problems. As suggested in the New Orleans example, the acceptance by engineers of this role will require that they free themselves from a position of only taking orders from employers. From a traditional engineering ethics perspective this alternative approach raises the problem of "many hands." Is it still possible, if so many stakeholders are involved in defining and solving design problems, to allocate specific responsibilities to the engineers involved when things go wrong? Perhaps or perhaps not. But because of the scale and complexity of many design problems today such a problem cannot be avoided.

3.2 Design Limits

Our second observation, related to the first, concerns the limits of design. Material systems may in principle be designed from the point of view of total design control, along the lines indicated above. For socio-technical systems this is problematic, if not impossible, because the behavior of the agents within the system is generally unpredictable. This is also a well-known aspect of architectural design. Agents that are part of socio-technical systems may redesign parts of the system from within in unforeseen ways.[14] As such, there may be no single vantage point from which complex systems can be designed and controlled. Moreover, if some agents within a system try to change parts of it in predictable ways, the total effect of all these changes at the system level may be unintended and unpredictable. In part this may be

[13] For a possibly dissenting opinion, see the work of Bucciarelli (1994).

[14] For example, see Andrew Feenberg's (1995) now well known example of the "subversive rationalization" of the Minitel in France by users. See also Brand (1994).

due to the complexity of socio-technical systems. Some critics even argue that such systems exhibit a kind of emergent behavior.

A concrete example of this phenomenon is *Wikipedia*, an on-line, free and "open source" encyclopedia that is edited by its users. Although this reference tool was created by the few individuals who comprise the not-for-profit *Wikimedia Foundation* in 2001, responsibility for the content of the encyclopedia rests with the community of users who claim that the interests of human knowledge are best served by the diffusion of responsibility. If true, such properties will raise even more problems regarding the moral and social responsibilities of engineers who participate in such open source systems. Who is morally responsible or politically accountable for negative effects related to the emergent behavior of complex socio-technical systems? Current theories in ethics, with its traditional focus on individual responsibility, may not be suited to deal adequately with such questions. Several new developments in STS and engineering ethics may provide some avenues to address these concerns, which brings us to our third observation.

3.3 Engineering Ethics

Three new developments in engineering ethics, if successfully prosecuted, could help to push the scope of responsibility in engineering design closer to architecture. First, Deborah Johnson and Jameson Wetmore (2007) have suggested that a fruitful starting point for such an engineering ethics can be found in combining STS with practical ethics. They observe that until now thinking in engineering ethics has been based on a separation of technology from its social context and on the idea that technological practices are free from social, political, and cultural values. According to them engineering ethics has mainly addressed the business context of engineering. They identify three core ideas in the STS literature that can transform engineering ethics so that it can more adequately deal with the sort of problems we have been raising:

1. The claim that technology and society co-determine each other which produces a weak form of technological determinism.
2. The long recognized observation in STS of the "socio-technical" nature of all technology.
3. The argument that technological expertise does not derive from value-free knowledge alone, but is partly constituted by social factors.

The claim is that the integration of these core ideas in engineering ethics will allow the field to critique more soundly the claim that technological design is morally value neutral.

A second new approach in engineering ethics is "value-sensitive-design."[15] This approach agrees with the idea that socio-technical systems are the primary unit of

[15] Friedman (1997).

analysis in engineering ethics. Socio-technical systems are by definition value-laden systems and designing such systems is, by definition, a value-laden activity. Value-sensitive-design would explore the consequences of this recognition for engineers. It takes as its starting point the idea that it is possible to pro-actively design social and moral values into technological hardware, for example, designing communication devices so that they safeguard the value of privacy. Such ideas may be familiar in architectural practice but they are relatively new in many engineering domains. One ironic example is the design of household heating appliances in Sweden documented by the social anthropologist Annette Henning. In order to realize the national goal of using more renewable resources for home heating *in lieu* of imported oil, the Swedish government collaborated with industry engineers to design bio-pellet burning stoves and furnaces. Much to the disappointment of all parties, however, this campaign for technological change proved to be unsuccessful because the appliances proved inconsistent with cultural "perceptions of house and home, of private and public space, and male and female space." In response to Henning's findings, the editors of the volume in which this study appears note that "Knowing how to design a heating system that will work mechanically is quite different from knowing how to design a system that users perceive as responsive to their domestic practices and values."[16]

A third new approach for engineering ethics could be derived from recent developments in architectural practice itself. Earlier we briefly discussed the need for the justification of whistleblowers in engineering to unmask design practices that, in the name of efficiency, may ultimately prove to be harmful to citizens or the environment. In this context we can understand a whistleblower as a member of a system but also a citizen of the society served. Part of the recognition of the whistleblower is that citizenship demands a higher order of loyalty than membership of a government agency or firm.

In the world of architecture some have likened Prince Charles to a kind of whistleblower at least in the sense that his activism in the preservation of historic architecture and urban patterns answers to a larger sense of responsibility to the public. But, as the Prince of Wales, Charles is both more than a citizen and less than a participant. He is a privileged observer of the system from the outside. The phenomenon of the "citizen-architect" may, then, provide a better exemplar for engineering practice. In Germany, Peter Hubner; in England, Rodney Hatch; and in the United States, the late Samuel Mockbee (of the Rural Studio), Sergio Palleroni (of the BaSiC Initiative), and Brian Bell (of Design Corps) are such citizen-architects who are engaged in what they call "community design." These design practitioners argue that their authority to design public facilities derives not from their status as licensed professionals but from the local communities in which they build. Rather than resent the eclipse of artistic autonomy that accompanies community design, these designers tend to see expressions of local values as the source of creativity, not its suppression. Design, in their view, is an inclusive social process in which

[16] See Henning (2005).

people decide how they want to live – it is not an autonomous process in which experts define problems and hand down answers from above. These practitioners are not simply populist order-takers committed to turning technocratic hierarchies upside down. Rather, they are highly skilled architects who hold that design excellence depends upon the creative synergy between the abstract knowledge of the expert and the local knowledge of the user. At its best, value-sensitive-design is not simply the accommodation of local values in the designers' vision of the future, but a transactional process in which designers and citizens depend upon each others' knowledge in the production of a better world.

In sum we believe that design practices in general will improve in proportion to the degree we can distinguish between *efficient* and *successful* technological systems. For any system to succeed it must be sustained – which is to say continually renovated over time – by the citizens whom the system serves and who in turn serve it.

4 The Essays

The ordering of essays in this volume is chosen to reflect the integrated understanding of engineering and architecture as we have characterized it here. The first part contains nine essays on engineering designing in the traditional "nuts-and-bolts" sense. These essays are authored by philosophers of technology and together provide an overview of current philosophical analyses of technology aimed at establishing that engineering is more than an activity only concerned with composing material products. Having been written within different philosophical traditions and with different aims, all nine essays relate engineering design and its products to ethical, political, and societal issues. The section opens with four essays by Maarten Franssen, Wybo Houkes, Don Ihde, and Philip Brey. These essays have in common a focus on the relationship between the products of designing and the intentions of their designers, their direct users, and the communities of consumers that determine their continued existence. The positions argued for diverge, sometimes radically, concerning the influence that the original intentions of designers can have on the characteristics of the products. Yet, regardless of these differences and regardless of whether the focus is on individual products and design process, or on more collective historical developments in technology, a recurrent theme is that for understanding design and its products, a wider focus is needed than one that is limited to the products themselves.

These essays are followed by chapters from Anke Van Gorp and Ibo Van de Poel, Peter-Paul Verbeek, Patrick Feng and Andrew Feenberg, Kiyotaka Naoe, and Paul B. Thompson. All of these essays enrich the analyses of engineering design with more explicit normative perspectives. The focus in these essays ranges again over a wide spectrum, from ethical decisions taken in individual design process, to the way engineering can alter society by changing the economic characteristics of various goods. These essays make clear the position of many, if not most, philosophers of technology that engineering, like architecture, shapes our lives and our societies – a conclusion that becomes unavoidable when new forms of engineering are considered.

The second part of the volume contains ten essays on engineering design in its novel forms as it is currently emerging. From a technological perspective the split between these two parts may be clear; from a philosophical standpoint there is a more gradual distinction since the ethical, political, and societal claims that can be made when considering these emerging forms of engineering design can often be made through more traditional philosophical approaches. Yet, the current novelties in engineering also bring new issues to the table, or older ones in more lucid forms. Bioengineering and genetic engineering, for instance, raise a whole new avenue of issues concerning what it is to be human, when the by now realistic possibility of reengineering ourselves in considered.

In the three first essays of the second part – those by John P. Sullins, Bernhard Rieder and Mirko Tobias Schäfer, and Alfred Nordmann – designing in three such emerging engineering technologies are analyzed, showing how, respectively, robotics, software engineering, genetic engineering and nanotechnology encroach upon and change our thinking and evaluation of technology as it has been shaped by the more classical forms of technology. Bioengineering and genetic engineering applied to or envisage to be applied to humans, set apart the next three essays by Daniela Cerqui and Kevin Warwick, Inmaculada de Melo-Martín, and C.T.A. Schmidt. These range from a full acceptance and embrace of our trans-human future (especially as exemplified by Warwick's work), to the articulation of a range of serious objections to a future engineered humanity. The final four essays by Kristo Miettinen, Ulrich Krohs, Kathryn A. Neeley and Heinz C. Luegenbiehl, and Noam Cook, bring us to the designing of socio-technical systems. These essays argue for a systemic approach to technological design. Within design practices, technical artifacts are not to be taken as objects on their own, but as elements of wider systems that not only contain technical elements, but also human beings and social elements. Only in this way it will be possible to take due account in engineering design of the close relationships between technical artifacts, human agents, and social contexts.

Finally, the emerging shifting focus in engineering design from technological products proper to socio-technical systems, provides the link between engineering and architecture and to the third part of the volume containing six essays on architectural design. Here, several authors take up the question of the future of architectural design, urban aesthetics, and civic engagement in the context of newly emerging architectural forms. The first four essays by Howard Davis, by Steven A. Moore and Rebecca Webber, by Ted Cavanagh and by Joseph C. Pitt are historical, empirical, and philosophical in scope. Davis finds that in the 19th century the process of designing buildings became separated from the process of building them. Using empirical methods, Moore and Webber reinforce Davis' historical evidence by examining the masked politics found in the technology of linear perspective. Taken together, the three authors agree that the abstraction of architects and citizens from the material conditions of building has had negative consequences that can be countered only by innovations in design practice. Cavanagh and Pitt, although from differing perspectives, argue against the notion that we can generalize about the various environmental design disciplines or that any particular discipline can successfully exercise a universal approach. In sum, all of these authors argue that successful, or good, design is situated in a particular social and ecological context. The last two essays by Graig Hanks and by Glenn Parsons take up the problem of how we should effectively evaluate the aesthetics of built space, as an extension of models of civic engagement and natural functions. Together, these essays provide a comprehensive overview of the promise of a more unified approach of understanding the combined architectural and engineering design aspects of built spaces.[17]

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