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).