and economic considerations, and the generally ill-defined nature of design problems, such that there is no given optimal solution to the design problem. Both of these considerations explicitly provide the opportunity for ethical reflection, even if the position is taken in the end that ethical intervention by the engineers is not justified. Questions arising out of the process of making trade-offs might be: "How should one decide, for example, on the relative importance of safety versus costs? Who is to make this decision? The engineers, the manager or principle [sic] of the project, the portrayed users, the people possibly affected, the general public? And how is this decision to be made in an ethically acceptable way?" (2001, 19). In relation to the ill-defined nature of engineering design, Van Gorp and Van de Poel conclude in a preliminary fashion based on their study: "If requirements need to be further operationalized, which is regularly the case, or if requirements cannot all be met at once, which is also regularly the case, this seems to trigger off reflections on and discussions relating to requirements. Ethical aspects can, but do not necessarily, play a part in these discussions" (2001, 21).

Given the need for trade-offs and the ill-defined nature of engineering problems – especially when we consider the combination of social, ethical, and technical aspects – no one optimal solution exists for an engineering problem. Once this is recognized, then the issue of choice can come to the fore, along with a sense of responsibility for one's actions. In terms of traditional engineering ethics, this means that considerations of the impact of the design on the public and its safety, on the natural and human environment, and on the utilization of different types of natural resources can come to the foreground. Engineering ethics, conceived in this fashion, can be broadened to cover issues beyond traditional ones such as confidentiality and conflicts-of-interest. The focus on design as a process imbued with ethical considerations makes possible a wider perspective on the societal implications of technology than the technologically governed emphasis on production, progress, and efficiency.

The difference in emphasis between the two ways in which we can discuss the work of engineers can guide us in overcoming the barriers to ethical reflection by the creators of technology. How do we draw on our understanding of sociotechnical systems to identify fruitful ways of talking about the process and increase awareness of ethical choices? To begin with, we know that we need to be very careful about the kinds of sociotechnical systems that we put in place. As Hughes' (1987) concept of technological momentum reminds us, we generally experience a foreclosing of options once a choice has been made and a system put in place. This means that ethical reflection must be seen as being appropriate throughout the design process, especially at its earliest stages. Johnson, Gostelow, and King in *Engineering & Society* (2000) paraphrase Hughes saying, "Once the first step has been taken, it is difficult if not impossible to stop a development.…detailed discussion is essential *before* the technology proceeds" (2000, 542).

Johnson et al. describe the first step of the design process in familiar terms: "Review the problem area and select the need that is to be addressed" (2000, 293), and go on to comment, "Both the review of the problem area and the choice of the specific need that is to be addressed are relatively subjective processes. They set

the design agenda and belong in a broadly political and commercial strategic domain. *Engineers should be encouraged to be much more involved in this key part of the design process*. [emphasis added] This is the point at which broad issues such as ecological sustainability of design outcomes are most effectively addressed. It is also where basic ethical choices are made about professional priorities, including what problems and issues will and will not be addressed" (2000, 291 and 292). This kind of framework redefines the engineer's sphere of appropriate analysis and decision-making in a way that is much more conducive to a sense of openness and choice – and, thus, to ethical responsibility.

If we can draw on what we do know about sociotechnical systems, we also need to realize what we do *not* know. A compelling discourse of design must be based on a sound philosophy of engineering, which is in turn based on a sound philosophy of technology, and poses three basic questions: How does technology evolve? How are the choices made as to which potential technologies will be developed and which ignored? Who makes these choices? (Ihde paraphrased by Johnston, Gostelow, and King, 2000, 542) Although we have made progress in answering these questions, we have yet to answer them in ways that engineering practitioners find easy to operationalize. Furthermore, a key task for the philosophy of engineering will be to reconcile the macro level of philosophy of technology with the micro level that Martin and Schinzinger describe as the "individual as the ultimate locus of action" (1989, 331). Broader responsibilities inherent in the process of design can be brought to the awareness of engineers involved in the design process; however, the question of the extent to which engineers as designers are justified in imposing their own values on the process of technological development remains a key issue (Luegenbiehl, 1985, 93). This last point highlights the importance of addressing the way both engineers and non-engineers think about and discuss the work of engineers.

6 Developing a Compelling and Accessible Narrative of Individual and Collective Empowerment

One way of overcoming the current dichotomy between discourses of individual responsibility and technological inevitability is to refocus the discussion of technological progress and individual determination around a common theme that captures a wider sense of responsibility within the framework of human intention. As an example, we will here use William McDonough's "Centennial Sermon on the 100th Anniversary of the Cathedral of St. John the Divine, New York City" (McDonough, 1993). He points us toward a process by which we can develop a compelling narrative in which engineers as responsible moral agents play a key role and where relevant decision-making junctures can be identified. It is notable that McDonough – an architect, not a minister or theologian – chose to cast his first formal public declaration of his perspective on the creation of technology in the form of a sermon and to deliver it in a cathedral. From the outset, his ideas are framed both literally and figuratively in contexts of traditional moral and ethical authority. He also uses biblical