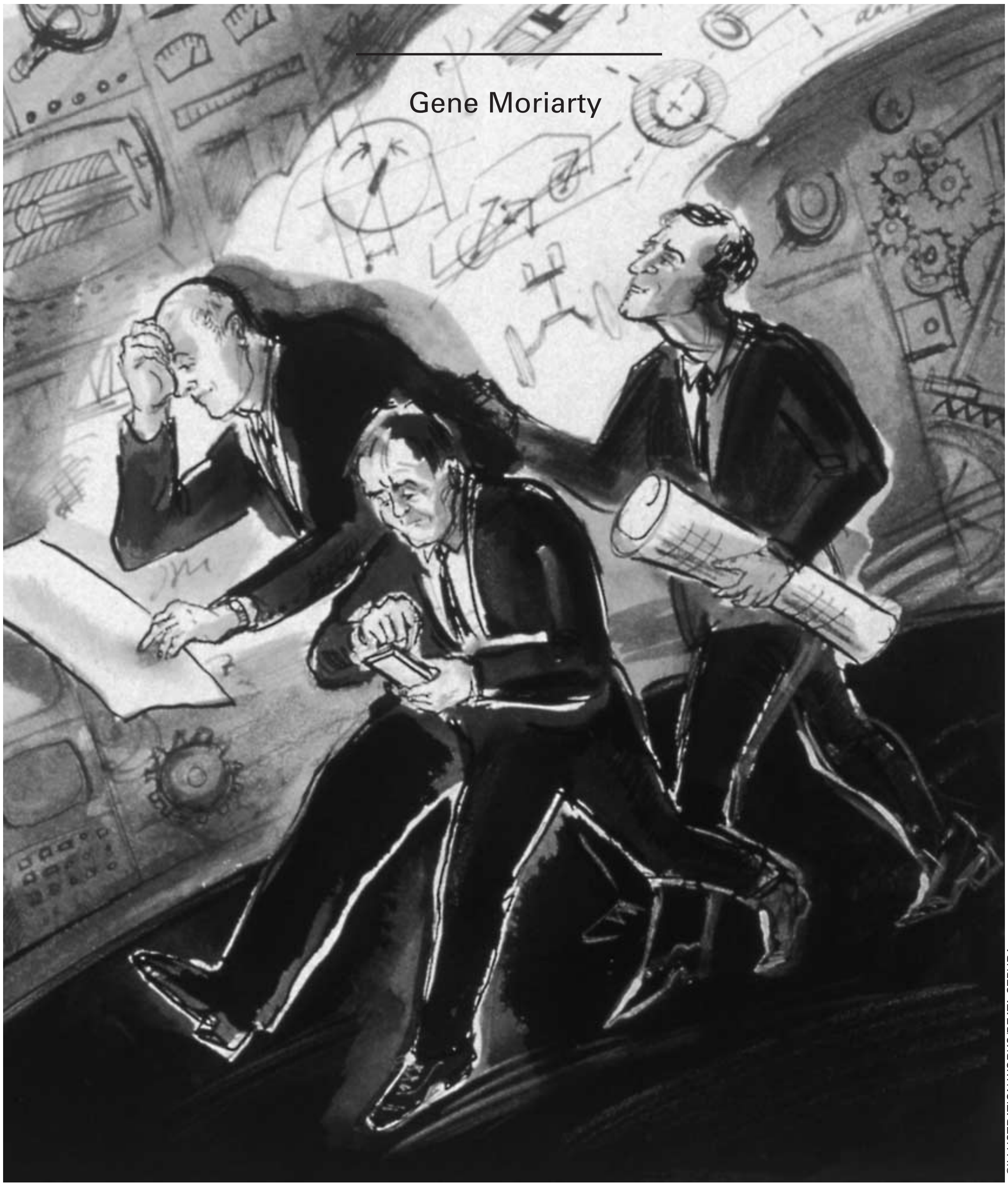
Three Kinds of Ethics for Three Kinds of Engineering



Authentic discussion of the *nature* and *ethics* of the engineering enterprise requires consideration of context. Yet, engineers typically take context as an add-on, often as a feature we are forced to address. The social context of engineering, for example, is often reduced to strategies for compliance with FCC or EPA regulations. Context is marginalized and seldom given voice by contemporary engineering practice.

But, context is world, and engineering is inherently and fundamentally an in-the-world enterprise. The impetus to drive the engineering enterprise comes from the world and the products of the enterprise are let loose into the world. Ignoring its fundamental worldliness allows the engineering enterprise to ignore its social responsibilities and to treat its engagements as if they were dictated entirely by market forces.

More and more, socially and environmentally responsible engineering ventures are garnering positive social regard. In general, recognizing and recouping the fundamental worldliness of engineering will likely embellish the enterprise by giving it a better image, a more unequivocal stature in the human community. What kind of context conditions and colors the way engineers engineer the engineered? What are the dimensions of that context? Economic and environmental aspects are not the only considerations. Political, historical, and psychological concerns are all involved. So are social justice and quality of life issues, as well as a concern for the common good, and mention of the "good" brings ethics explicitly into the picture.

Virtue ethics asks how the engineer can **be** good in the moral sense.

The phenomenon of the engineering enterprise stands within a web of contextual relationships, and the elements of *the engineer*, *engineering*, and *the engineered* stand out as fundamental to the engineering enterprise. Each element is contextual in the sense of being integrated into a more or less coherent realm of discourse consisting of thoughts, actions, words, things, roles, and goals. That realm of discourse indicates the contexts that condition and are conditioned by the engineering enterprise.

Corresponding to each of the three aspects or elements of the engineering enterprise is an appropriate and distinct type of ethics. *Virtue ethics* is appropriate to the engineer who engineers the engineered. It asks how the engineer can *be* good in a moral sense. *Conceptual ethics* is appropriate to engineering, which aims at the production of the engineered and requires the engagement of engineers. It asks how engineers can *do* good engineering. *Material ethics*, promoted by philosopher of technology Albert Borgmann [1], is appropriate to the engineered, which follows from the engineering process via the efforts of the engineer. Material ethics asks how engineering can *make* products that contribute to the common good in a convivial society. Being, doing, and making are all bound up in the statement: the engineer engineers the engineered. We cannot separate engineer, engineering, and engineered – either from each other or from the contexts in which they are embedded – but we can distinguish them and with each we can associate a different kind of ethics.

Historically, the engineering enterprise has exhibited a variety of modulations in the engineer/ engineering/engineered trilogy. Three such modulations, distinguishing three types of engineering enterprise, correspond roughly to past, present, and future. In the era from the Egyptian pyramids to the Medieval cathedrals, an orientation of pre-modern engineering I call *traditional engineering* was paramount. From the dawn of the modern age to the present time an orientation of engineering I call *modernist engineering* was and is dominant. For the future I advocate a new orientation of postmodern engineering, which I call *focal engineering.* It is a specific kind of practice, as proposed by Borgmann [2], that would aim to bring into the world devices, organisms, structures, systems, and networks that help to gather, focus, and orient our lives. Focally engineered products ought to contribute to a good life, a life of *engagement* (following Borgmann), *enlivenment* (following the criterion for structures suggested by architect Christopher Alexander [3]), and *resonance* (drawing on a notion familiar to electrical engineering and fundamental to eastern religions as well).

These three orientations of engineering, although corresponded with specific temporal eras, are, have been, and will be possible at any time. The contemporary engineering enterprise, however, is for the most part modernist. But the modernist enterprise includes

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the way of knowing intrinsic to the traditional orientation. Traditional engineering is grounded in a way of knowing characterized as knowing-how, while modernist engineering is grounded in both knowing-how and knowing-what. A purely traditional engineer in contemporary times would probably be seen as a technician rather than an engineer.

Engagement in the broadly conceived focal engineering enterprise is admittedly rare within contemporary engineering practice. Focal engineering includes the ways of knowing of the modernist and traditional orientations and is based in an epistemology of knowing-how, knowing-what, and knowing-why. Though I advocate focal engineering, I am not implying that traditional and modernist engineering need to be abandoned. They are in fact subsumed by focal engineering and all three types of engineering need to work in harmony for the sake of enlivening, engaging, and resonating as well as efficacious ways of being.

My suggestion is that since traditional engineering emphasized the person, the engineer, virtue ethics was, or should have been, or should be the right type of ethics for traditional engineering. Although within traditional engineering the person is fore-grounded, the process and the product still exist. They do not disappear, but are merely back-grounded. In a like manner, modernist engineering emphasizes the process of engineering and conceptual ethics is suitable for this kind of engineering. For focal engineering, which stresses the engineered product, material ethics is most appropriate to gauge the prospects for good of the product to be let loose upon the planet.

Traditional Engineering and Virtue Ethics

The traditional engineering enterprise was inexorably tied to social and political worlds bound by the non-democratic and generally repressive rule of pharaohs, emperors, and kings. The traditional engineering enterprise, then, exhibited a truncated ethicality from the point of view of the traditional engineer. What the engineered – the *project* of traditional engineering – was to be was largely dictated to the engineer by the powers that be. This is still true today, but the contemporary engineer can at least change jobs if dissatisfied. The traditional engineer probably did not have that option. The traditional engineering *process* was largely implicit, lacking a clear and distinct form that could be put under the gaze of ethical scrutiny. Actual engineering practice proceeded, for the most part, by intuition, rough estimates, and design experience. Process and project, engineering and engineered, then, were back-grounded within the traditional engineering endeavor, but the person, the traditional engineer as engineer, had some freedoms and some responsibilities. Ethical concern could emerge regarding the character and behavior of the traditional engineer in ancient times. Such an engineer was probably like a modern era foreman or official overseeing the design and construction of engineering projects.

Slaves may have built the pyramids, but engineers engineered them. Who were these engineers? Of the little that is known about engineers and the details of engineering projects in ancient times, there is evidence that some ancient engineers were of high, or at least interesting, character. Something of the character of the ancient engineer is seen in the epitaph Egyptian engineer Ineni (circa 1500 BC) wrote for himself:

> "I have become great beyond words. I will tell you about it, ye people. Listen and do the good that I did, just like me. I continued powerful in peace and met no misfortune; my years were spent in gladness. I was neither traitor nor sneak, and I did no wrong whatever. I was foreman of the foreman and I did not fail. I never hesitated but always obeyed superior order, and I never blasphemed sacred things" [4].

Ineni was not exactly a modest fellow, but he knew his place and acquiesced to his superiors. For the most part, in the extant social hierarchy, ancient engineers were comfortably ensconced between the powerful and the powerless. Most engineers today are similarly ensconced. Many today would see ideal virtues embedded in Ineni's words. The character of this engineer, or a less exaggerated version thereof, was probably typical of many traditional engineers.

My suggestion – that within the traditional engineering enterprise, in the engineer/engineering/engineered trilogy, the engineer predominated – suggests that character issues should be paramount. Jumping a few millennia from ancient Egyptian times to the mid-19th century, we find Samuel Smiles maintaining that the successful 18th and 19th century engineer was "orderly, regular in his habits, disciplined, predictable, methodical in his problem solving, even-tempered, and law-abiding" [5]. A straight shooter. Not cynical like many moderns and postmoderns. The virtues Smiles pointed out would benefit the traditional engineer and the engineer of the 18th and 19th centuries. Many of the virtues encouraged in the character of yesterday's engineer would support today's engineer and tomorrow's engineer as well.

Smiles' books were very popular in the 19th century. They mirrored the individualism that was advancing in the modern era. The rugged individual was making more and more available the products that the commodious individual could consume [6]. And these individuals were often the same person. Individuals of high principle and integrity, who were honest, open-minded, and industrious – as championed by Smiles – could be entrusted to bring forth a world worth living in. “Smiles reflected his age and also influenced it. He wrote especially of engineers, inventors, and industrialists as they transformed their environment – and society – through rapid industrialization” [5, p. 1].

In his *Lives of the Engineers,* Smiles tells the story of several engineers, including James Brindley, John Rennie, and Thomas Telford. Brindley was an interesting example of what I am calling a traditional engineer, even though he lived in the modernist era. He was a self-taught genius. He could only minimally read and write. Yet he was very observant and

> “ready at devising the best methods of overcoming material difficulties, and possessed of a powerful and correct judgment in matters of business. Where any emergency arose, his quick invention and ingenuity, cultivated by experience, enabled him almost at once unerringly to suggest the best means of providing for it. His ability in this way was so remarkable, that those about him attributed the process by which he arrived at his conclusions rather to instinct than reflection – the true instinct of genius” [5, p. 166].

The lack of a modernist scientific method or procedure did not stop Brindley or the traditional engineer of the pre-modern era from the enactment of monumental projects and the achievement of great works. Intuition, instinct, and experience – pivotal to the skills and know-how of the traditional engineer – were revealed in the ways he/she conducted his/her life. The power of character, so it appears, compensated the traditional engineer for the lack of explicit methods, means, and procedures. Character is developed over a long period of time and requires the practice of the virtues: character issues are the concern of virtue ethics.

Virtue ethics, stemming largely from the Nicomachean Ethics of Aristotle, has been enjoying a revival in ethics discourse in the past several years. Though increasingly relevant to contemporary engineering practice, virtue ethics provides the essential measure for gauging the character of the traditional engineer. Even before the Greeks, the ancient Egyptians followed lists of precepts or codes of conduct, which provided advice on how to be a good person. The lists and codes, however, were not grounded in theoretical frameworks. Similarly, in the Babylonian laws, put forth by Hammurabi, no attempt was made to defend the principles of justice on which they were based [7]. Much of the ethics in ancient times was aimed at helping one to be a good person, rather than providing conceptual justification for doing good things. Of course, if one is good, one will likely do good.

> Conceptual ethics asks how engineers can **do** good engineering.

The ancient Greeks said that to be good was to be of good character and good character was attained by the practice of the virtues. Virtue ethics, today as well as in the ancient world, might suggest the practice of virtues like objectivity, care, and honesty to distinguish the engineer as a person of integral character. And what exactly is character? Character is a power, a faculty, a capacity. Or as Ralph Waldo Emerson put it: “this is what we call Character – a reserved force that acts directly by presence, without means” [8].

Modernist Engineering and Conceptual Ethics

Means, methods, and procedures became explicit within the modernist era, which began with the Renaissance and extends into contemporary times. The engineering enterprise gradually came into its own as a unique practice, thanks in large measure to the development of a clear and distinct methodology. The methods of modernist engineering were exhibited in the process whereby engineering was actually practiced. Engineering as process in the engineer/engineering/engineered trilogy began to stand out. The characteristics of the process began to matter more than the character of the engineer. The act became more important than the actor. In late modern times, for example, in computer-automated-manufacturing systems, the actor appears to disappear altogether. But appearance is not reality: in fact the person and the product, engineer and engineered, merely were back-grounded within the project of modernist engineering as the process of engineering itself moved to center stage.

Contributors to the early development of modernist engineering included Leonardo da Vinci (1452-1519), Francis Bacon (1561-1626), and Rene Descartes (1596-1650). Da Vinci used science in a serious way as an aid to his engineering projects. Bacon advocated the marriage of theory and practice for the benefit of humankind. And it was Descartes' method that engineering embraced.

By grounding the largely implicit method of traditional engineering practice in Descartes' notions of *abstraction*, *dissection*, *reconstruction*, and *control* [6, p. 35], the method was made explicit within modernist engineering. Then, fortified with an increasingly fruitful methodology, engineering began to be seen as applied science and as design. The procedures of abstraction and dissection are basic to the practice of *analysis*, while reconstruction and control are basic to *synthesis*. Proliferation of analysis procedures brought science more and more into the service of modernist engineering. Scientific knowing-what gathered momentum as a major aspect of modernist engineering processes, particularly the engineering design process. The marriage of know-how and know-what, of theory and practice, gave birth to an engineering process that began to crystallize into a coherent form. Its separate aspects emerged in various circumstances, dissected and reconstituted many times over, so that at the present time the engineering process is running along smoothly in the fullness of its being and articulatedness.

The question arising throughout the development of the modernist engineering enterprise is how *ought* the process to proceed? As enacted by the engineer, the engineering process required a gauge of its activity. Doing morally good engineering would seem to presuppose that one is a morally good engineer, practicing, for instance, the virtues of care, objectivity, and honesty. But what else is involved? New ethical frameworks were called for. How do we address the issues of health and safety that were of concern to the engineering processes that the industrial revolution was producing? The steam engines of Thomas Newcomen and James Watt added tremendous efficiency to many engineering processes, benefiting primarily the wealthy and educated people who had a steak in these processes. The condition of the poor and uneducated, however, was not generally advanced. They were often further disenfranchised, giving rise to social justice issues. These and other concerns encouraged the modernist engineering enterprise of the 19th Century to begin to come to grips in a more formal way with its social responsibility.

The incorporation of ethical standards within modernist engineering gave rise to its professionalization. The engineer became less a foreman overseeing engineering projects, like the traditional engineer, and more a professional implementing engineering processes. The establishment of professional engineering societies in the 19th Century, including the American Society of Civil Engineers (1852), the American Society of Mechanical Engineers (1880), and the American Institute of Electrical Engineers (1884), gave ethics a forum in which conflicts concerning the 'ought' could be resolved. The ethics of the day sprung from the work of Jeremy Bentham (1748-1832) and John Stuart Mill (1806-1873), who developed and promoted the philosophy of utilitarianism, the concept that advises us to do whatever advances the greatest good for the greatest number. A generation before Bentham and Mill, Immanuel Kant (1724-1804) gave ethics the concept of the *Categorical Imperative*, which advises us to act in such a way that, if everyone did the same, the good would be served. It also advises us to always treat others as ends in themselves, never as means for some other purpose. These notions of ethics, which I call conceptual ethics, guided the ethicality of actions and dominated the modernist era and modernist engineering in particular. Conceptual ethics is to the act, the process of engineering, as virtue ethics is to the actor, the engineer. Though the character or virtue of the engineer was still important, conceptual ethics began to be fore-grounded in 19th Century deliberation concerning the good. The engineering process came under the scrutiny of various schemata of conceptual ethics.

Conceptual ethics came into the service of modernist engineering quite naturally because modernist engineering and conceptual ethics were both grounded in the general scientific and theoretical mind-set that characterized the modernist world-view. Egbert Schuurman calls that world-view *technicism*.

> "Technicism reflects a fundamental attitude which seeks to control reality, to resolve all problems with the use of scientific-technological methods and tools. Technicism entails the pretense of human autonomy to control the whole of reality. Human mastery seeks victory over the future. Humans are to have everything their way. We want to solve all problems, including the new problems caused by technicism; and to guarantee, whenever possible, material progress" [9].

Conceptual ethics arose in keeping with the worldview of technicism but also as a critique of or a damper on the unbridledness at the core of technicism. The emerging professional engineering societies, where these ethical theories were played out, struggled to balance their freedoms and their responsibilities, and these struggles crystallized into codes of engineering ethics. Today, the dimensions of conceptual engineering ethics, as well as various aspects of virtue ethics, are encapsulated succinctly in a number of professional engineering codes, like the IEEE Code of Engineering Ethics [10].

Material ethics asks how the engineer can **make** products that contribute to the common good in a convivial society.

FOCAL ENGINEERING AND MATERIAL ETHICS

Assume that an engineer is of virtuous character, practicing, say, objectivity, care, and honesty in her/his everyday dealings with the engineering enterprise. Assume this engineer sticks closely to his/her code of ethics in the enactment of his/her engineering process, striving always for environmental sustainability, products that are safe, and equitable distributions of the resulting benefits. The virtue ethics and conceptual ethics assessments may be totally positive. It may still be the case that the products brought into the world are deadening or disengaging. Readers, I am sure, will have their favorite examples of this. Ubiquitous computing immediately comes to my mind. In a possible scenario, all my household appliances are networked. My toaster talks to the fridge in which are the bagels whose container senses the disappearance of the bagels and informs my Internet agent who is preparing my shopping list for the week while simultaneously balancing my household expenditure accounts. To be is to be wired. But as a colleague of mine puts it: "the smarter my house gets, the dumber I get." Too much disburdenment leaves me disengaged. Are there options?

This is where focal engineering and its material ethics assessment make their appearance. Focal engineering aims at the good and material ethics assesses how close it gets.

Material ethics is concerned about the material products, which are the outputs of the engineering process, the engineered in its various manifestations of system, device, structure, organism, or network. Do they or how can they serve the good? The notion of the good is of course wide-ranging. It requires a conversation, the conversation of the life-world. I am suggesting that we look at if and how the engineered product can itself be a focal thing, or how it can serve focal practices. Focal things are things that gather and enrich our earthly sojourn. Focal practices are habits of the heart and mind that unite and focus our lives and orient them toward the good life in a convivial society. It might be argued that the engineered device can be used for good or ill depending on the whim of the user, but the device has *in its own right* an orienting force. That force can be directed toward or away from the good. Take the common example of TV. We can watch PBS and feel virtuous, or we can watch trash and turn ourselves into zombies. But just the mere fact of there being a TV in the living room can modify the attunement of our lives. Is *that* modification a movement toward or away from the good? Even if there is no answer to that question, it must be asked as part of the enactment of material ethics.

Focal engineering is an orientation of the engineering enterprise that is dissatisfied with just know-how and know-what; it needs to also know-why, or at least look for the whys and the wherefores, whences and whithers, causes and purposes, reasons and consequences. Focal engineering is not content just to do no harm. It seeks to actually contribute to the common good in a convivial society with the products its process brings forth. Good in what sense? I am suggesting that the material ethics assessment of focal engineering should examine the moral worth of the engineered by looking at whether or not it contributes to engaging, enlivening, and resonant ways of being. I employ Borgmann's term *engagement*, which for him has wide-ranging reverberations. I look at engagement in a more narrow sense, taking it as a measure of the harmony between the product and the beneficiary or the end-user. A strong engagement would get a positive assessment, a weak one a negative assessment. Secondly, I take Christopher Alexander's notion of enlivenment as a measure of the harmony between the beneficiary and her/his world. Lastly, I take the idea of resonance as a measure of the harmony between product and world. Of course, product and end-user are enworlded, and world, end-user, and product are bound up with each. They cannot be separated but they can be distinguished.

Now, the world involved in the material ethics assessment of focal engineering is the same world that provides context for the engineering enterprise in general. Typically overlooked by modernist and traditional engineering, world is at the heart of the focal engineering proposal: that the outcome of the focal engineering process must be good, do good, or contribute to the good, within the context of the end-user's involvements. Being-in-the-world means being bound up with social and political contingencies. How can the products that engineers create resonate with the social and political dimensions of our world? Such worlds, in which and to which beneficiaries of focally engineered products are fettered, can be thought of as engineering ecologies, along the lines of information ecologies, as discussed by Nardi and O'Day. [11] Such an ecology indicates a "local habitation."

> "By this we mean settings in which we as individuals have an active role, a unique and valuable local perspective, and a say in what happens. For most of us, it means our workplaces, schools, homes, libraries, hospitals, community centers, churches, clubs, and civic organizations. For some of us, it means a wider sphere of influence. All of us have local habitations in which we can reflect on appropriate uses of technology in light of our local practices, goals, and values" [11, p. ix].

Looked at through the lens of material ethics, the project of focal engineering aims to make the engineered ecology engaging, enlivening, and resonant as a result of incorporation of this or that system, organism, device, structure, or network. What kind of prospects does a focally engineered system or device need if it is to provide enlivening, engaging, and resonant material scenarios? It must be able to provide enrichment and fullness of contextualized being, conceptual continuities, and community attunements. Of course, these mean different things to different people. We initiate the conversation of the lifeworld, opening the dialog as the point of departure for focal engineering. The conversation of the lifeworld is the discussion that involves ordinary citizens, affected parties, and focal engineers seeking to arrive at an understanding of what it means to contribute to the common good. Within this conversation engineered products need to be assessed. Material ethics via its evaluative structures of engagement, enlivenment, and resonance can be brought to bear upon the decisions to bring a given product to fruition or to thwart its deployment into our focal ecology.

For instance, a dialog involving structural engineers, urban planners, architects, social activists, and concerned citizens must be enjoined if a new park is to be focally engineered in the center of town. Will the park provide people a place of gathering? Will the worlds of those who use it be embellished? Is the park going to resonate with the wider world in which it will be placed? The contemporary modernist engineer ordinarily works in a team of engineers that includes, for example, a test engineer, a design engineer, a manufacturing engineer, and others. The focal engineer is inevitably part of a team too, but his/her team involves more than just other engineers. A Technology Assessment type team, composed of representatives of the political, environmental, social, psychological, spiritual, etc., dimensions of the human lifeworld, would be appropriate for a focally engineered project. The team needs to weigh the deadening, disengaging, and dissonant possibilities out against the enlivening, engaging, and resonant prospects of any proposal for a new, or already existing, network, organism, structure, device, or system. What about, say, a new Internet feature: who will prosper from it, how, and why? What kind of community life enrichment can be expected as a result of employment of the feature? And these kinds of questions inevitably invoke others in an on-going and open-ended fashion. Closure does not come easy for the focal engineer and his/her material ethics assessments within the conversation of the lifeworld. But out of this conversation emerges the public policy decisions that delimit and condition the engineering enterprise, which in turn brings forth products, focally oriented, that contribute to the good life in a convivial world.

> Focal engineering is an orientation that is dissatisfied with just know-how and know-what; it needs to also know-why.

Face to Face with the Possibilities of Focal Engineering

The contemporary engineer is typically modernist, which implies that he/she takes on features of traditional engineering as well as a scientific perspective. Many projects, judgments, calculations, and decisions can be carried out in a traditional engineering way, relying primarily on know-how. Design, for instance, is often a matter of intuitions. But, increasingly, design tends to be science based, integrating know-how with know-what. Modernist engineering, increasingly and in an explicit manner, employs science in the service of all its methods and processes, especially the design and manufacturing procedures, which aim at not only benefiting investors but also creating a better world for all humankind. And the *aims* of these processes, as distinguished from the processes themselves and their methodologies, bring modernist engineering face to face with the possibilities of focal engineering. At this more exalted level of engineering, the enterprise can be directed toward the big problems of the day, like global warming, acid rain, ozone depletion, declines in biodiversity, growing rates of resource depletion, and exponential population growth. Yet focal engineering seeks most earnestly to act locally, to embellish local ecologies with products whose prospects are good for advancing the engaged life in a convivial society. The "best practice" for a focal engineering enterprise, in light of its ethical assessments, might be not to bring forth such and such, but rather to decide against letting loose into the world another product that would lead to disengagement and dislocation.

Material ethics is the discourse in which the engineered can be evaluated as to its possibilities for engagement, enlivenment, and resonance. Value functions might include equal measures of these three, or unequal measures if consensus warrants. Other or different criteria can certainly be considered. The structure I present here is meant to be suggestive. Kicking off the conversation of the lifeworld is the important thing. Unless a certain valuation is attained, by whatever details one incorporates in his/her versions of material ethics, the product would be deemed unacceptable as far as material ethics is concerned. Negotiation and dialogue among stakeholders is required. Voice must be given to the disenfranchised persons who may be affected by the proposed product. The focal engineering dialogue in connecting to the conversation of the lifeworld must especially engage public policy people.

As engineering educators, we owe it to our students, future engineers and citizens of the world we are now constructing, to open the dialogue of material ethics, along with the more standard concerns of virtue ethics and conceptual ethics. Raising *why* questions, as well as how and what questions, can enrich our classroom interaction by encouraging engagement with the idea of the good. As Langdon Winner puts it: "Our moral obligations must now include a willingness to engage others in the difficult work of defining what the crucial choices are that confront technological society and how intelligently to confront them." [12] Clearly, the crucial choices for the ideal engineering enterprise are choices about engineered products that are to be brought into the world or kept in the world.

Since the engineer and engineering are so integral to the engineered, virtue ethics and conceptual ethics integrate with material ethics in the ideal engineering enterprise. The ideal practice of engineering is characterized by a tasteful harmony of traditional, modernist, and focal engineering structures. The engineer/ engineering/engineered trilogy resonates with the context or place of an enlivened and resonant engagement. We can, perhaps, be at home in such a place, but we are, of course, a long way from home.

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