Techné 5:2 Winter 2000

The Place of Engineering and the Engineering of Place

By Gene Moriarty
Department of Electrical Engineering
San Jose State University

ABSTRACT

The role or place of engineering is to engineer place, a location of engaging life events. That is the case for focal engineering, which is distinguished from two other kinds of engineering: traditional engineering and modernist engineering. These three kinds of engineering are discussed in terms of ways of knowing appropriate to them: *know-how* for traditionalist engineering, *know-how*/know-what for modernist engineering, and *know-how*/know-what/*know-why* for focal engineering. Various notions of place and space are relevant to the three kinds of engineering discussed. In traditional engineering, place and space are backgrounded. In modernist engineering, space begins to dominate, causing a disharmony in the place/space constellation. In focal engineering, place is stressed in order to re-harmonize the place/space constellation.

INTRODUCTION

These days, most people conflate their everyday understanding of space and place, both of which are, after all, answers to the question "where." Place, space, site, receptacle, locality: all these words overlap in meaning. But, on closer investigation, significant differences between notions of space and place do appear. On the one hand, place can be taken as a location of shelter, security, groundedness, memory, and dwelling. Being at home with family and friends is the classic example of being in place. On the other hand, space can be taken as a location of exposure, freedom, and openness. A lone car, speeding along at 100 mph through the Nevada desert on one of those endless hypnotic stretches of interstate highway, is an example of being in space.

The automobile, in fact, has taken us for a ride in more ways than one. To be sure, like most products of engineering practice, the automobile has promised relief from our burdened estate (Borgmann 1984, 35-40). For many, for instance, a new sports car provides quintessential relief from the burden of boredom. And so many Americans, it seems, yearn to hit the road, to free themselves from the grasp of local traditions and values. Others want to hit the road but then go off-road so they can conquer a terrain accessible only to fourwheel drive vehicles. But such “liberations” are not without their costs, chief among which – for purposes of this paper – have been the disintegration of social and spiritual cohesion, disrupted connections and continuities that had been essential to a felt sense of place.

Place is becoming displaced, not only because of the automobile, but also because of other forces confronting the world today, more general forces, like universalism and individualism that contribute to the prevailing world view and spirit of contemporary times (Borgmann 1992, 51-57). Universalism professes to transcend the particulars of place in pursuit of larger explanatory principles. Individualism backs away from the integrality of communally defined places in favor of willful self-assertion. In the wake of the abandonment of place, there remains only space, space taking the place of place. For example, the wide-open space of multi-lane freeways, often clogged with cars carrying only one person, replaces a local life of particular things and communal connections. Connections on freeways, in fact, are called accidents. Yet, before the automobile, the vast majority of people lived connected lives, staying close to home in familiar places, with familiar people, in the well-worn grooves of traditional culture.

What has been the role of engineering in the process of displacing place? The displacement of place appears to be an unintended consequence of the liberations secured by engineering practice. Civil engineers, for example, participate in the design and construction of a new shopping mall. The mall centrally locates shops and saves shoppers from having to go to several different places. But though they offer convenience and efficiency, malls tend to be depersonalizing. And as people leave their neighborhoods to go to malls, local engagements are attenuated. Engineers rarely address the consequent disruption of community cohesion. Yet, on the positive side, new kinds of communities can arise within mall culture. Seniors, for example, often gather in malls for exercise and companionship. Positive and enlivening possibilities need to be weighed against displacing tendencies. Certainly, in general, engineering enterprise has contributed to the progress of Western society and to the technological advancement of all humankind. Engineering has promoted – via design, development, and production of devices of all kinds – a disburdenment from unpleasant, unhealthy, obstructive, and onerous tasks. The engineering feat of harnessing nuclear energy for power, for instance, has joined coal power and hydro-electric power to lift the burden of darkness for city dwellers. And the entertainment a CD player provides is a virtual reality that disburdens the listener from having to go through all the trouble of attending a live concert.

But, as Albert Borgmann (1984, 40-48) has pointed out, disburdenment tends to result in disengagement, the separation of the engineered product and those who use it from context. And disburdenment tends to result also in displacement, which can be taken as disengagement plus dislocation. What if the benefits of disburdenment were in danger of being washed out by costs stemming from displacement and disengagement, costs such as loss of community coherence, alienation of family members from each other, and addiction to conspicuous commodity consumption? Within the world of contemporary engineering practice, such evaluations are seldom enjoined. "The least understood cost – although probably the most keenly felt – has been the sacrifice of a sense of place: the idea that people and things exist in some sort of continuity, that we belong to the world physically and chronologically, and that we know where we are" (Kunstler 1993, 118).

Traditional Western cultures, seemingly more implaced than modern cultures, had their own kind of engineering. It was primarily focused on practices of planning and building and was largely state supported and managed. I will call it traditional engineering. It was instrumental in bringing into being a wide array of structures, from ancient pyramids to medieval cathedrals. The kind of knowing appropriate to it was knowing-how, and the exercise of a range of skills was at the core of traditional engineering practice.

Modernist engineering, focussing more on machines and devices than on structures, was more antagonistic to a sense of place than traditional engineering had been. Modernist engineering came into prominence at the dawn of the modern European era, becoming professionalized in the 19th Century, and continued to flourish in the Western world in contemporary times. The kind of knowing appropriate to it is knowing-how coupled with knowing-what. The engagement of theory and practice has produced many a disburdenment but, unfortunately, just as many disengagements or displacements. A pivotal reason for the displacing tendency within modernist engineering is that it takes things in terms of only measurable properties, filtering interpretations of reality through a Cartesian space-time grid, necessitating a suspension if not a suppression of the ambiguities and particularities of place.

To counter the displacement and disengagement that tends to result from modernist engineering practice, I want to articulate and to advance a different kind of engineering, an engineering of the future, that promotes enlivening of place and enlivening of a diversity of people, and human life-events, and things belonging to place. I call it focal engineering, which I take as a specific focal practice, in Borgmann's sense (Borgmann 1984, 196-210). The kind of knowing appropriate to focal engineering requires not only knowing-how and knowing-what, but also knowing-why. It is a kind of engineering that is hardly ever of concern to mainstream discussions of the role of contemporary engineering practice. But lest we "continue to thicken," as Borgmann puts it, "the suffocating overlay of disposable reality" (Borgmann 1993, 299), perhaps it ought to be.

Though each type of engineering is associated with a specific historical time period – past, present, and future – all three types are and have been possible at any time. Traditional engineering will be possible tomorrow, as focal engineering was possible yesterday. Modernist engineering, however, has a kind of hegemony and ubiquity within contemporary engineering enterprise. And the stress on space in modernist engineering has imbalanced the space/place harmony typically taken for granted by the traditional engineering practice. The stress on place in focal engineering aims to re-harmonize, in an explicit manner, the space/place constellation.

TRADITIONAL ENGINEERING

During the era from the ancients to the moderns, traditional engineering played a subservient role to more intellectual or scientific endeavors.

> "The great cultural achievement of ancient Greece was undoubtedly the development of a scientific sense. The Greek was in fact the first Man of Theory. His life was devoted to and in a higher sense formed by, scientific understanding. Technology generally ranked in the Greek world below science" (Klemm 1964, 18-19)

Traditional engineering was a practical activity, requiring hands-on skills and intuitive judgments, but that's not to imply that it was without a knowing aspect. All ways of humanity have some kind of knowing associated with them, including the range from the very abstract purely knowing-what something is to the very concrete knowing-how this or that works. Both of these kinds of knowing, along with a more comprehensive knowing-why, were part and parcel, at least to some degree, of traditional engineering practice. But what and why questions, along with space and place questions, became secondary to the foundational *know-how* of traditional engineering practice. Two separate tracks or ways of being began to unfold in ancient times: the thinker's path of theoria and the doers path of praxis. The accord of theoria, including space/place discourse, with traditional engineering praxis, was typically a matter of intuitive harmonies, seldom a result of an explicit application of theory into practice. A glance at a Roman Aqueduct system, for example, suggests a fortuitous place/space harmony, manifest in an integration of the structure with its physical context, a pleasing display of noble architecture and rugged functionality that endures still today.

Among ancient thinkers, as illustrated in the following story from Plutarch, there was a strong disdain of practical application and an extreme value ascribed to pure theory. There were once two mathematicians, Eudoxus and Archytas, who tried to solve a problem of finding two mean proportional lines, which at that time was a problem incapable of being solved by rigorous mathematical argument. They employed mechanical analogies and heuristics, like arrangements of curved lines and sections, all of which were fairly obvious to everyday, practical sensibility.

> "But Plato was incensed at this, and inveighed against them as corrupters and destroyers of the pure excellence of geometry, which thus turned her back upon the incorporeal things of abstract thought and descended to the things of sense, making use, moreover, of objects which required much mean and manual labor. For this reason mechanics was made entirely distinct from geometry, and being for a long time ignored by philosophers, came to be regarded as one of the military arts" (Klemm 1964, 21)

As forms of doing, rather than thinking per se, mechanics and "military engineering" were not exactly held in high regard by Plato.

Traditional engineering practice, in general, rarely involved a direct application of abstract scientific principles. Still, as the heart has reasons of its own, praxis has its own kind of theoria. And theoria means more than just theory. It's the way one sees the world, which in turn is a way of taking the world, taking up with the world, and being-in-the-world. The theoria of traditional engineering praxis incorporated tacitly understood skills and techniques, heuristics, trial and error, indirect use of science and mathematics, use of building and planning experience, intuition, and – as Plato would point out

– lack of rigor. But traditional engineering proceeded, and so it still does today, for example, in contemporary engineering projects that proceed without mathematical rigor, simply on the basis of design experience and intuition, or in the work of some craftspeople and artisans. A contractor, for example, might engineer – in the sense of traditional engineering practice – a retaining wall on the basis of past experience and general rules, without the use of detailed mathematics or scientific rigor. Of course, a contractor can be considered an engineer only in a very loose sense. But that sense is gaining currency in contemporary times with proliferation of expressions like “engineering one’s portfolio” or “engineering one’s relationships.” Notwithstanding, the ideal of the modernist engineer is exactly the skilled hands-on practitioner of traditional engineering coupled with the theoretician grounded in mathematical and scientific disciplines. This ideal is the offspring of the marriage of theory and practice suggested by Francis Bacon at the dawn of the modernist era.

What about the ideas of place and space within the traditional era and how was traditional engineering related to these ideas? Though many minds contributed to the intellectual development of the historical era extending from ancient times through the medieval period, the thinking of Plato and Aristotle were monumental. For Plato, space as matrix or receptacle or chora was pre-given, preceding creation. “Just as chora precedes creation – it is what the Demiurge encounters upon his intervention into the scheme of things: hence its Necessity – so particular topoi ensue from creation” (Casey 1993, 35). (Topoi is the plural form of topos, the Greek word for place.) Necessary space preceded contingent place. Plato needed infinite, or at least indefinite, space as a pre-existing receptacle in which the forms and ideas existed as true reality, and out of which sprung the concrete places of everyday finite and sensuous localness. For Plato, the supersensuous space of essence held priority over the sensuous place of existence.

After Plato, however, Aristotle began to reverse that priority. On his way toward the sensuous, “Aristotle illuminates the role of place in the concreta of everyday life” (Casey 1998, 75). Concrete things constitute the particularity of place as topos. “To be is to be in place” (Casey 1993, 14). Even though place as topos spins off of and out of space as chora – and space thus precedes place in time – place can be seen as ontologically prior to space in the sense that place provides the conditions that make space possible. Humans must exist as beings-in-the-world, as implaced persons, in order to imagine notions of space. In any event, Plato was and is to space as Aristotle was and is to place.

As the era shifted from the Greek and Roman periods through the Dark Ages to the Medieval period, the philosophical debate shifted across many modulations from the place centered view, promoted by Aristotle, to more and more of a space centeredness. Traditional engineering sailed smoothly on a sea of these modulations, mainly because Plato and Aristotle and their progeny, along with their ruminations on space and place, remained for the most part in the background of the planning and building that characterized traditional engineering practice. That practice brought forth public works, like bridges, canals, aqueducts, docks, and harbors (Smith, et al. 1983, 21). These works were implaced in places and were themselves places, but typically the traditional engineer as builder and planner – being generally more integrated into his/her world than a modernist engineer would be – did not make place and space issues of explicit reflection. "Just as human beings had not radically separated themselves from the nature in which they existed, so their sciences and techniques were not distinct from the cultures they made possible and to which they contributed" (Mitcham 1999, 19:128). The embeddedness of traditional engineering practice in a context or world of *know-how* and skills generally left builders and planners little time and energy for full participation in a vita contemplativa.

For the most part, just as thinkers stayed on the path of theory, so did doers, including traditional engineers, follow the path of practical activity. But not always. Occasionally the twain did meet. Builders and planners in the military sector, though disdained by platonic elitism, served a praxis that was not separate from theoria. The design and construction of machinery required application of mechanics, application of general theories grounded in what today is called physics. Plato distinguished and elevated the pure science of geometry over and above the cruder science of mechanics. Yet mechanics and its application proved very useful in many a war effort. And the application of mechanics to practical problems in Greeko-Roman times served as a harbinger of modernist engineering, not yet a theory/practice marriage, but at least theory catches the eye of practice. In preparations for war, "Greece utilized both practical experience and calculation for the production of large machines" (Klemm 1964, 30). Abstract calculations proved to be useful in artillery making and in designing siege engines. Calculations were used in non-military traditional engineering, but minimally, not with the zeal and precision of military engineering. Military engineering, in ancient times, with a strong theory component, was atypical of praxis oriented traditional engineering. Military engineering, even today, is rich in scientific application of state of the art ideas. Some of the "sweetest" engineering projects, from the point of view of the theoretically oriented engineer, are found in the realm of military sponsored programs.

In the military versions of traditional engineering, notions of place and space underwent interesting transformations. Though not generally an explicit concern of practicing engineers, space, like the mathematical space of abstract scientific principles, expanded its domain of dominance, and place began its recession, especially in the sense that military machines, as opposed to non-military structures, served – among other things – to destroy place, namely, the place of the enemy. In modern times, unbridled military technology threatens to destroy primary place, i.e., the planet itself. The advance of space and the retreat of place that occurred in the backdrop of military engineering indicate that even in ancient times, this kind of engineering had a peculiar modernist sense. Modernist engineering, though focused temporally in the modern era – roughly the last four or five hundred years – was also alive, here and there, in ancient times and will surely continue on into an indefinite future.

MODERNIST ENGINEERING

While *know-how* characterizes traditional engineering practice, it is the marriage of theory and practice, bringing together know-what and *know-how*, that characterizes modernist engineering. Mathematical and scientific theories were advancing at the dawn of the modern era. In terms of these new theories, the essence or whatness of the universe was being revealed in clear and distinct fashion. And these theories – especially Descartes' analytical geometry and Newton's physics and calculus – were increasingly drafted into the service of planning, designing, and building the material world. With the advancement of theory goes an advance in the importance of space and general ideas along with a concomitant decline in the importance of place and particular things.

Following Plato's privileging of space, Aristotle promoted place as "an already occupied locus for fully formed material objects" (Casey 1998, 83). Between Aristotle and the modern era – in the philosophies of the Stoics, Epicurians, and Skeptics, through the Neoplatonic school and the ruminations of Medieval and Renaissance thinkers – local, particular, and concrete places were initially preeminent, but their preeminence gradually eroded due to increased circulation of objective, abstract, scientific, and general ideas and theories. The

‘New Science’ of the Renaissance period, for instance, proceeded from a few experiments to general conclusions, and these general conclusions were becoming more and more important. From these conclusions particular results were derived and tested for their efficacy and usefulness. As derived entities, however, they became of less importance than the general ideas from which they sprung. All these inductions and deductions were best ordered and executed in an abstract and rational space-time manifold of a mathematical and mechanical character. Space gradually supplanted place as modernity slowly dawned over the Western world.

A new style of human life began to emerge when the engaged and implaced self became “the private self as self-conscious spectator of the world” (Romanyshyn 1989, 70). Things as objects get placed over and against the self as subject and the subject/object dualism comes into sharp relief. Things implaced in places begin to get projected “as patterns of spatial relations reducible to measure, a projection which is in principle indifferent to the character of things so measured…” (Romanyshyn 1989, 79) The character of things gets interpreted as the properties of objects, mathematizable, analyzable, and able to be controlled by the aggressive and self-conscious thinking person. The world became a space or, more precisely, a space-time manifold of our own making, a space of points and plotted trajectories of points varying over time (Romanyshyn 1989, 79)

Engineering activity profited from these measures, these mathematizations, initially as an aid to the practice of planning and building, then as an ingredient in the analysis and design processes that were becoming crucial to the engineering enterprise, and ultimately as the sine qua non of all engineering, that which distinguishes the “real” engineer from the “mere” technician. Mathematics, queen of the sciences, and her royal subjects – including mechanics, thermodynamics, materials science, electro-mechanics, and especially today, information sciences – all serve modernist engineering. Today these sciences in the service of engineering are called engineering sciences. Among many contributors to the engineering sciences and to the modernist engineering project in general, at the dawn of the modern era, were three pivotal figures: da Vinci, Bacon, and Descartes.

Leonardo da Vinci (1452-1519) brought the scientific space of mathematics to bear on his diverse artistic and practical endeavors. The prototype of the Renaissance person, his scope was colossal. He made contributions in diverse fields, including sculpture, painting, graphic design, aviation, and machine design.

> "His extraordinarily developed power of illustration not only in the realm of the fine arts but also especially as regards technical structures, his familiarity, thanks to the Florentine workshop tradition, with the properties of different substances and the varied possibilities of their utilization in the workshop, and his labours to discover by experiment simple mathematical laws of nature, all these made him an engineer in the modern sense" (Klemm 1964, 125)

Da Vinci suggested that a rational structure of the universe exists and is observable through mathematics. Most of his works, especially his art, were things that contributed to place embellishment, yet as the first modernist engineer, Da Vinci brought mathematical space and time considerations more intensely to bear on his projects in a consistent manner than had any engineer before him. "But how, exactly, was mathematics to be applied to nature, and why should this combination yield a superior type of knowledge? Leonardo (da Vinci) did not say" (Jones 1969, 71).

Francis Bacon (1561-1626) articulated what da Vinci made manifest in his works, namely, the importance of the scientific attitude, especially the utility of using science to procure knowledge and the application of that knowledge to the practical problems of everyday human life. The power this knowledge procured was to bring relief to the burdened estate of humanity. But the ground this work was taking off from was cluttered with a number of metaphysical presuppositions carried over from previous centuries, issues like the dichotomies of form/substance and essence/existence, which were of little interest to the project of constructing a new world. This new world was to be based on a scientific method concerned primarily with relation. Relation was the ordering principle of the infinite space-time grid of the mathematico-logico-scientifico project, the theoretical framework of interpretation shaping the worldview that would condition and serve modernist engineering practice. Objects and events in abstract space, ideally formulated as mathematical relationships, began more and more to usurp things and occasions in concrete place.

Though Bacon aggressively sought to put theory in the service of practical human life, theory could not marry practice without each, in a sense, taming the other. Practice was often intuited, beyond the reach of explicit conceptualization, based on mere experience. In the new world of the New

Atlantis (1627), mere experience would be replaced by rigorous experiment. But pure theory was itself often frivolous, a speculative pondering of imponderables, bringing forth questions like how many angels can dance on the head of a pin? Bacon advocated clearing the ground to establish a tabula rasa on which the arts and sciences could be reconstituted. A clean slate would be obtained by purging knowledge:

> "of two sorts of rovers, whereof the one with frivolous disputations, confutations, and verbosities, the other with blind experiments and auricular traditions and impostures, hath committed so many spoils, I hope I should bring in industrious observations, grounded conclusions, and profitable inventions and discoveries" (Jones 1969, 74).

Industriousness in applying science for the advancement of the human condition was the central advocacy of Sir Francis Bacon, patron saint of the modernist engineering enterprise. Bacon's own proposals, however, especially his highly touted inductive method, left much to be desired, because in his proposals he assumed a notion of substance, precisely one of those frivolities he had condemned for the spoils they had wrought. It would take Descartes to provide the method proper for the modernist engineering project.

Rene Descartes (1596-1650) not only expressed optimism about science and its explanations, but also held "a firm belief in the progress of science and the future betterment of humanity" (Romanyshyn 1989, 180). Here, Descartes and Bacon were in accord. But Baconian methods, still caught up in the particulars of oriented place, were intolerable to Descartes' universal methodology. Bacon's inductive method started with concrete particulars and could not sever the ties that bind people and things to concrete realities. And Descartes' method did precisely that, promoting a fundamental severance called abstraction. As Borgmann puts it: "This is the triumph of procedure over substance. Bacon was still fascinated with the substantive features and details of the New World. In the Discourse, Descartes used concrete illustrations merely to demonstrate the power of his procedure" (Borgmann 1992, 24). The Cartesian method, privileging science and the scientific world view, is exactly what modernist engineering needed in order to give itself legitimacy. The method helped to shift engineering from being a tradition bound practice involving a set of skills and general rules to being a scientifically grounded enterprise, on its way to being a respected and honorable profession.

Descartes' procedure, the Cartesian method, has four elements: abstraction, dissection, reconstruction, and control. "Faced with a problem, one must first abstract from it – step back from it and regard it from a skeptical distance. One also needs to abstract the problem itself – sever it from its context and our tacit understandings" (Borgmann 1992, 35). Dissection of the problem into its simplest parts is then possible. These parts are ideally represented as points or sets of points located in an abstract three-dimensional space. Time is the independent variable. Dependent variables, as points or clusters of points, vary with respect to time. A knowledge of relationships between dependent variables, according to the Cartesian method, was necessary and sufficient to have complete information about the problem at hand. Once such information becomes available, reconstruction of a new entity or product or device can be achieved in terms of its abstracted and dissected parts. Control over the resulting entity completes the task.

The process or procedure of doing modernist engineering is known generally as the engineering method and more particularly as the engineering design process. It proceeds by breaking the problem down into a set of subtasks including modeling, simulation, proto-typing, testing, debugging, etc. These tasks are sequenced into stages and each has feedback from and to it in an on-going and evolving fashion. If the manufacturing process is involved, it can be viewed as another subtask in the overall process. A product, or at least a product design, emerges from the process and needs to be controlled. All the Cartesian elements are involved, that is, at the root of the engineering design process is the Cartesian methodology.

The Cartesian method embellishes the knowing-how of traditional engineering with a knowing-what as a scientific and mathematical overlay, a time-space grid in terms of which objects are understood and interpreted. The modernist engineering enterprise, grounded in engineering science and the variety of space-time manifolds embraced by the separate engineering sciences, commerces in the Cartesian space of clear and distinct ideas. The role or place of modernist engineering, has been to analyze, design, research, proto-type, test, develop, and manufacture systems, devices, and structures – whether real or virtual – that meet the needs, desires, and specifications of a client or customer.

Modernist engineering, in terms of a Cartesian methodology tied to a minimal cost criterion, seeks to design products that come into the world and take up residence in the neutral zone of free space. They are neutral entities in that they can be used for good or ill at the whim of the end user. A Honda Accord, a good solid car and a neutral entity, can be driven 100 mph and burn up a lot of gas and endanger a lot of lives, or it can be used for just puttering about town. The user chooses. The choice though is usually not between place and space, but rather between different kinds of space, because the car inherently provides a means toward liberation from place, a breaking away from place, and an invitation to explore alternative spaces. Nevertheless, even though engineered products are spatial elements, they may also contribute to place, and in more or less enlivening and engaging ways. The problem is that modernist engineering does not have the notions of engaging and enlivening in its lexicon. Consider any new product that springs out of the machinery of the modernist engineering enterprise. Whether or not it is enlivening or engaging is taken to be independent of the product itself and is seen to depend only on the end-user. Can the product itself actually promote enlivening and engaging interactions with humans? The engineering of precisely this kind of product is the aim of focal engineering.

FOCAL ENGINEERING

While the marriage of theory and practice characterizes the modernist engineering enterprise, theory and practice in context is required for focal engineering. As far as the objects and devices that populate the modernist engineering space-time continuum are concerned, know-what and *know-how* are both necessary and sufficient for successful application of the engineering method. However, the *know-how* and know-what of modernist engineering need to be integrated with *know-why* in order to bring context into the picture. Why questions point into context and bring context to bear on the steps of the engineering methodology.

For example, as a modernist/focal electrical engineer, I know what's important in a digital control system design. I know what the major components are: the digital-to-analog converter, the analog-to-digital converter, the "plant" or system to be controlled, the sensors, and the compensator. And I know how these devices work. For instance, I know how the analog-to-digital converter is based on the process of sampling, and I know how it is that the faster I sample, the better my results will generally be. But do I know why control systems are important? Sure. They contribute to extending human power over various domains of life. Why is it important to have such power and control? Thusly am I disburdened from much onerousness. Why do I want to be disburdened? Because then I can be free for more interesting things. Why is freedom important? Et cetera, et cetera. *Why* questions keep unfolding into the nested contexts of our worldly involvements. *Why* questions, common enough in an everyday sense in everyday discourse, are marginal to modernist engineering practice, but they are explicitly required for the contextually sensitive practice of focal engineering.

Why questions, however, encompass a broad scope. "Why" means how come or as a result of what is something as it is, and it also means to what end or for what purpose is something as it is. *Why* questions tend to bifurcate into whence and whither questions. Whence questions ask for formal or material or efficient causes. Whither questions ask for the final cause, the goal, the telos. But whence and whither questions, as such, are not specifically what is at issue in why questions. Their coordination is the key, as indicated by the Greek word phronesis, "practical wisdom, or knowledge of the proper ends of conduct and of the means of attaining them; distinguished by Aristotle both from theoretical knowledge or science, and from technical skill" (Runes, ed. 1975, 235). Knowing why or phronesis contextualizes knowing what and knowing how. Phronesis has three major characteristics (Haroutunian-Gordon 1-2). First of all, a person of practical wisdom should be able to deliberate well and arrive at proper conclusions via the act of reasoning. Secondly, the goal or end should be attainable by acting. And, lastly, that goal should be good. Technical skill or *know-how* is more specialized than the *know-why* or how-come of practical wisdom, phronesis. *Why* questions inform the practical wisdom of the focal engineer.

Some questions within modernist engineering practice started out as why questions but got transformed along the way into what and how questions. Why is this or that product important in terms of environmental or social impact? reduces to what must be done to meet minimum EPA standards? And why is this or that product important in terms of beauty in the world? becomes what embellishments can be added to a product to make it more appealing to the customer? The ultimate *why* question for focal engineering to entertain is why bring this or that product into being in the first place? The only acceptable answer, from the focal engineering point of view, is because the product at issue is to be an implaced product and will contribute to the Good, the True, and the Beautiful. That means it will itself become a place, nourishing engaging human life-events, in the context of other such places, or at least it will contribute to the enlivening hospitality of place.

Place in general, then, is not strictly the aim of focal engineering. Not just any place will do. A place must be a good place. But in what sense of good?

I associate with focal engineering Borgmann's notions of focal thing and focal practice, for which the characterization of engagement is paramount (Borgmann 1984, 196-210). Focally engineered products should support the good, in the sense of a human life of harmonious connections and continuities in which the fullness of being-for the other and being itself is experienced. But this says more about the person engaging with the product than the product itself. And what about the product? It must be enlivening, not deadening, to use the language of architect Christopher Alexander (Alexander 1979). And people and products ought to be integrated, they ought to be one, in the Heideggerian sense of belonging together, with the emphasis on the belonging. (Heidegger 1969, 28-37). Focal engineering, then, favors and fosters a sense of place wherein humans can sink roots, or can dwell, where "dwelling is the capacity to achieve a spiritual unity between humans and things" (Harvey 1996, 300-1). And that place and the humans and things therein must be engaging and enlivening.

Focal engineering is to place as modernist engineering is to space. And while focal engineering does not necessarily entail replacing space with place, it does aim to promote and nurture place in order to redress the imbalance of space over place that is typically found in modernist engineering practice. Ultimately, focal engineering aims for a tasteful balance and harmony between space and place. A focally engineered product, for example, might emerge out of a communal consensus hammered out by engineers, farmers, politicians, energy conservation advocates, and concerned citizens. It might be something like the pollution-free windmill power project started in the 1970s by the folks of Jutland, which is the part of Denmark extending northward from Germany into the North Sea. "Thousands of the sturdy white spinners, mostly owned by farmers and farm cooperatives went up across the blustery peninsula, steadily increasing the share of national electricity generated from the wind" (Durning 1994, 99). Communal interactions and decisions to enhance the good of society both promote a sense of place, while the windmills themselves are located in physical space and were designed and planned in the conceptual space of rigorous engineering practice. This is place and space in harmonious accord.

Focal engineering seeks to engineer products that are inherently implaced things, things that help us dwell. Implaced things are not neutral but are integrated into their context and conditioned by their context, and the objective is to engineer them in such a way that they are turned toward and tuned to engaging connections and enlivening continuities within the contexts of the people who might be taking up with these products. A solar or methane or propane powered car, for instance, could prove to enhance engagement by requiring more attention to details of content and limitations of context. Within focal engineering practice, the contextual embeddedness of the automobile inevitably comes into view. Questions emerge about what it would take to revamp the larger transportation system of which autos are a part. How to be, vis-a-vis transportation, humans who are more fully implaced on the planet? For instance, at first, start small and stop driving quite so much, maybe only every other day, while the car's solar cells recharge. Take a bus, which can certainly be an implaced thing, a place to meditate, read a book, or talk to new people. Focal engineering suggests that the values of public transportation systems deserve more acceptance and enthusiasm. More generally, focal engineering promotes the nurturing of a sense of place – via the products of its practice – in order to counter the increasing placelessness of contemporary times

Focal engineering strives to bring products into the world that will enliven and embellish the patterns of human life-events and eventful things that constitute places as lived worlds. It is not difficult to see this with structures, like bridges or roads. Consider the example of a structure Alexander uses, namely, a courtyard. The structural engineers involved in a courtyard design and construction might be teamed with architects, homeowners, real estate people, and environmentalists. The focal engineer would promote on his/her team an enlivening place where people "can sit under the stars, enjoy the sun, perhaps plant flowers" (Alexander 1979, 109). The structure and materials that comprise the courtyard must be in accord with the patterns of human life-events that occur there, and the people who will use the product determine those patterns.

> "If they pass in and out of the courtyard, every day, in the course of their normal lives, the courtyard becomes familiar, a natural place to go … and it is used. But a courtyard with only one way in, a place you only go when you 'want' to go there, is an unfamiliar place, tends to stay unused … people go more often to places which are familiar" (Alexander 1979, 109).

Other features that make courtyards enlivening are a smooth transition from inside to outside, via a porch or veranda, and a variety of paths in the courtyard, some of which are crossing. "The view out makes it comfortable, the crossing paths help generate a sense of habit there, the porch makes it easier to go out more often … and gradually the courtyard becomes a pleasant place to be"(Alexander 1979, 109). The courtyard becomes an enlivening place.

But if walls enclose a courtyard leaving no opening to a larger world, the courtyard produces a claustrophobic sense and is a deadening place. If it has no porch or veranda as a space halfway between inside and outside, it does not invite people in and it is a deadening place. If the courtyard has no crossing paths and only one path leading out to it, people will not frequent it. "They hope to be there, but the lack of paths across the courtyard make it a dead and rarely visited place, which does not beckon them, and which instead tends to be filled with dead leaves, and forgotten plants" (Alexander 1979. 110).

An enlivening product integrates smoothly with the patterns of human life-events that characterize any particular place. These products, of course, may transform these patterns, but they do so, or ought to do so, in such a way that the patterns are embellished. The enlivening patterns, enhanced by focal products, contribute a sense of stability and harmony to the lives of the human beings who use these products, as well as to the people who design and manufacture them.

Products as structures, like bridges and courtyards, are one thing, but what about devices? A device is something for something else, so its presence is deferred or concealed, while its commodity aspect is revealed. Structures are devices too but they have a concrete physical presence that can be enlivening or deadening. A non-structural device is an appliance or an instrument, a device in Borgmann's sense of the Device Paradigm: its physical or mechanical presence disappears or recedes as its commodity aspect is made available. (Borgmann 1984. 40-48) The entertainment provided by TV is the commodity and – in its most advanced form – the physical TV, the "box" itself, disappears into the wall. Is TV an enlivening product that embellishes patterns of implaced human life? The "box" itself certainly is not. The commodity of entertainment is generally deadening and disengaging. At best TV is a neutral product of modernist engineering practice: watch only high quality shows and avoid the garbage and it can provide positive experience; or use it, but don't let it use you.

Modernist engineering always strives to provide a more advanced commodity. Color TV replaces black and white. HDTV replaces color. Computers replace TV in general by providing what TV provides and more. Now ubiquitous computing is poised to replace the current wave of computers "in a box." But this chain of replacements contributes to a displacement of the patterns of an enlivened and engaged human life. Ubiquitous computing, for example, aims to satisfy needs that are more and more trivial. Do I really need to be told by a computer chip embedded in my milk bottle that I'm running out of milk and need to get some more? It seems that many of these replacement/displacement chains are running out of imagination and trickling off into the trivial and the disposable. Focal engineering might find a role, a place, in the promotion of what Borgmann calls a commanding reality as a counter to the “suffocating overlay of disposable reality” (Borgmann 1993, 299).

As far as non-structural devices are concerned, the focal engineer aims to engineer products that contribute to enlivening rather than deadening life events or focal practices. Borgmann’s famous example of the focal practice of running suggests that the focal engineering of the ideal running shoe might be a worthy device to help enliven a focal practice (Borgmann 1984, 196-210). More familiarly, electronic device engineering is a major concern of thousands of engineers today, most of whom would find it hard to relate to the notion of focal engineering as described herein. They strive to get more and more computing power on smaller and smaller pieces of silicon real estate. Nevertheless, the chips they design are for something, something bigger. To shift into a focal engineering purview, an engineer needs to inquire about the nature of this something. What is the device for, the device that will embed the chip? How does it add beauty to the world? In what way does it embellish human life-events or focal practices? Why should it be brought into the world? Why does it or why does it not support the good life in a convivial society? And these questions open up other questions and other discourses.

The person/product accord, aim of the modernist engineering project in general and of the human-computer-interface (HCI) movement in particular, is necessary but not sufficient for focal engineering which aims at a person/product/world accord. HCI seeks to have machines be more human, which is certainly a good idea. But humans, concomitantly, tend to become more machine-like, i.e., structural, rigid, de-contextualized, procedural, spatial, and displaced. Integrating world as context into the person/product accord helps to diffuse these negativities. And that integration is precisely the aim of the practice of focal engineering. World is context and is intentionally brought to bear on the focally engineered product or person/product conjunct. The larger patterns must be allowed to speak. They are part and parcel of focal engineering. They add their share of dependable structure to the lived world.

While modernist engineering may incorporate a larger pattern here and there, it does so only when social forces – acting from outside the modernist engineering enterprise – demand attention, as is often the case with environmental constraints. And in regard to modernist engineering:

> "because business, commerce, and politics have to a large extent remained outside what engineering counts as its own validating or explanatory discourse, the engineering profession lacks an adequate definition of human or community needs on which to base ethical judgments on its activity. The subordination by engineering science of all other discourses means that engineering has defined its practice as lying outside the context in which it occurs" (Johnston, et al. 4).

But the *know-how* of modernist engineering practice and the know-what of modernist engineering science, in side-stepping context, also fail to aspire to the practical wisdom or phronesis of focal engineering as it seeks a person/product/context accord. Recollection of context slows down focal engineering and makes it less progressive, but certainly more holistic, than modernist engineering. Admittedly, one of the constraints that prohibits a full enactment of focal engineering is the modernist engineering quest to minimize "time to market." How does a company maintain its competitive edge? How to mitigate the determining power of market forces, then, is another question for focal engineering to ponder.

The focally engineered product brings the ideas of The Good and The Beautiful back into the picture. As Ken Wilber (Wilber 1998, 50-56;106-107) has suggested, The Good and The Beautiful have been suppressed by the hegemony of The True in the modern era. The modern Western world had dispersed the cultural spheres of morals, art, and science, which before the Renaissance had been intimately intertwined.

> "By the end of the 18th century, scientists, artists, and moral/cultural theorists were all going off doing different things with very little communication among themselves. This led to fragmentation and alienation. A very aggressive science, coupled with industrialization, was allowed to colonize and dominate the realms of morals and art. With the good and the beautiful removed from science, the only truth was materialism, which led us to our current disaster" (Wilber 1998, 55).

Engineers engineer worlds. They create aspects of human lived worlds by the products they put into these worlds. To thwart the growing dominance of The Bad, The Ugly, and The False, focal engineering by knowing how, what, and why – or at least by asking how, what, and why questions – tries to put in place products and practices that contribute to The Good, The Beautiful, and The True.

CONCLUSIONS

In a recent Letter to the Editor in the IEEE Technology and Society Magazine, Robert Brook takes Langdon Winner to task for insisting that engineers be contextually sensitive:

> Winner is unrealistic in his desire that engineers become politicians and policy mavens. It is not the purpose of the designer of a more efficient power supply or a class A amplifier to look for its ramifications in the area of social justice. The economic need is where engineering design starts. Engineers certainly cannot be held accountable for the unintended and unforeseen consequences of technological development – many of which turn out to benefit society (Brook 1999, 4).

Mr. Brook appears to be making a category mistake here. He is criticizing Professor Winner from the point of view of modernist engineering, whereas Winner had been promoting attitudes and perspectives that resonate with what I am calling focal engineering. The "modernist" and "focal" notions point to two different categories of engineering, the latter being more inclusive than the former. And though a given engineer may adopt different features of each category, to varying degrees at various times, the distinction should help to clarify issues, especially when focal engineering is advocated and is taken to be at odds with modernist engineering.

I am not suggesting that modernist engineering should be abandoned. It will persist, as will traditional engineering. Modernist engineering will hopefully bring forth products that are user-friendly, that exemplify values of ideal modernist engineering practice, including versatility, durability, simplicity, and stability. Nevertheless, the product that is well engineered and achieves these ideals, and that satisfies professional standards of safety, efficiency, and bottom-line cost effectiveness may, in spite of all these wonderful aspects, still have a gravely deadening effect on the well-being of hapless users. The danger – to paraphrase Heidegger on technology – is not modernist engineering per se, but rather the exclusiveness of such a practice. Without alternatives, the world would have to endure, as it in fact does today, many deadening or disengaging effects. To counter these effects, to promote things and products that have character, focal engineering is called for.

Focal engineering is a kind of engineering practice that has in view the bigger picture of what contributes to The Good, The True, and The Beautiful.

Such a picture is populated with embellished human life-events and with enlivening and engaging products that are themselves implaced focal things or serve focal practices that embellish patterns of place. Alive places and the occasions therein, the eventful events, have character indicated by virtues like integrality, beauty, sustainability, and resonance, that is, they exhibit a fullness of being that is charged with ineffable spirit, which Alexander calls “the quality without a name” (Alexander 1979, 19-40).

Focal engineering as a professional discipline is one element in the pattern of the larger social order, and, as such, the field has an honored place alongside other pursuits such as architecture, environmentalism, psychology, economics, and social justice movements. Representatives of these and other disciplines should collaborate in the construction of a focally engineered and implaced world. This collaboration involves on-going technology assessment. The recently defunct Office of Technology Assessment (OTA) should perhaps be revived. Only this time with a less ambiguous charter. Incorporating Borgmann’s notion of engaging focal things and practices, as well as Alexander’s notion of enlivening rather than deadening products could set the OTA out – to paraphrase Robert Frost - on a path that is less traveled by, but one that can make all the difference.

REFERENCES

Alexander, Christopher. *The Timeless Way of Building.* New York: Oxford University press, 1979. 109-10.

Borgmann, Albert. *Technology and the Character of Contemporary Life.* Chicago: University of Chicago Press, 1984. 35-210.

——. *Crossing the Postmodern Divide.* Chicago: University of Chicago Press, 1992. 24-57.

——. "The Moral Significance of Material Culture," *Inquiry*, 35(1993): 299.

Brooks, Robert. "Letter to the Editor," *IEEE Technology and Society Magazine,* Summer (1999): 4.

Casey, Edward. *Getting Back into Place.* Bloomington: Indiana University Press, 1993. 4.

——. *The Fate of Place.* Berkeley: University of California Press, 1998. 35-83.

Durning, Alan Thein. "Seven More Wonders," *Utne Reader.* March/April (1994): 99.

Haroutunian-Gordon, Sophie. "Aristotle's *Phantasia* and its Role within *Phronesis*: A Question," an essay at: http://www.ed.uiuc.edu/E…hautunian-gordon.html. 1-2.

Harvey, David. *Justice, Nature &the Geography of Difference.* Malden, MA: Blackwell Publishers. 1996. 300-1.

Heidegger, Martin. *Identity and Difference.* trans. Joan Stambaugh (New York: Harper & Row. 1969. 28-37.

Johnston, Stephen, et al. "Engineering as Captive Discourse," *SPT Journal.* at: http://scholar.lib.vt.edu/ejournals/STP/v1_n3n4/Johnston.html. 4.

Jones, W.T. *A History of Western Philosophy: Hobbes to Hume, 2nd Edition.* New York: Harcourt, Brace & World, Inc. 1969. 71.

Klemm, Fredrich. *A History of Western Technology.* trans. D. W. Singer. (Cambridge: The MIT Press, 1964. 18-21).

Kunstler, James. *The Geography of Nowhere.* New York: Simon & Schuster, 1993. 118.

Mitcham, Carl. "Why Science, Technology, and Society Studies?" *Bulletin of Science*, *Technology & Society.* Vol 19:2 (1999). 128.

Romanyshyn, Robert D. *Technology as Symptom & Dream.* London: Routledge, 1989. 70.

Runes, Dagobert D. ed. *Dictionary of Philosophy*. Totowa, NJ: Littlefield, Adams & Co., 1975. 235.

Smith, Ralph J., et al. *Engineering as a Career, 4th Edition.* New York: McGraw-Hill, 1983. 14.

Wilber, Ken. Interviewed by Mark Matousek, *Utne Reader*. July/August (1998). 50-107.