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Technical Expertise, Sustainability, and the Politics of Specialized Knowledge[i]

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The dominant role of technology in contemporary societies requires the public to rely on individuals with specialized knowledge to invent, design, manufacture and maintain increasingly complex artifacts and networks. As Stilgoe et al. (2006: 16) note, "Our everyday lives are played out through a series of technological and expert relationships." In spite of the increasing reliance on technologies and technical expertise, there has been an erosion of trust between the public and technical experts since the 1970s as contemporary environmental, social, and economic problems have revealed the limitations and unintended consequences of scientific and technological development. Thus, the role of technical experts in contemporary society is in flux. The emphasis in recent decades on creating more sustainable modes of life has only increased the tensions between scientific and technological development, environmental impacts, social conditions, and specialized knowledge.

In this chapter, we draw on work from the fields of environmental sociology (Hajer 1995; Dryzek 1997; Hannigan 2006), political science and policy analysis (Fischer 1990, 2000, 2006; Irwin 1995; Bäckstrand 2003, 2004; Stilgoe et al. 2006), and Science and Technology Studies (Sclove 1992, 1995; Moore 2001, 2007; Brand 2005a) to explore the relationship between experts and non-experts in environmental and sustainable decision-making. These authors have examined how specialized knowledge of technical experts and the informal knowledge of non-experts has been expressed in environmental politics, policy debates, urban development, and other venues.[ii] Of particular interest is how experts from different disciplines interact with one another and the public they are ostensibly chartered to serve.

We begin with an overview of the ascendancy of the technical expert in contemporary society and a summary of the critiques of expertise. We then provide a brief discussion of sustainability, with particular emphasis on how it differs from previous conceptualizations of environmental problems, and question how traditional models of expertise fit within this new paradigm. Finally, we present four models of expertise that have been applied since the 1980s to create more sustainable modes of human life and conclude with a discussion of the implications that sustainability has for technical experts in the future.

The Rise of the Technical Expert

The beginnings of technocracy–or perhaps more accurately termed "expertocracy"–can be traced to the Enlightenment when individuals began to acquire or were granted the power to shape and direct societies through scientific and technological development. Their efforts produced large complex systems including gas, electric, water, sewage, and transit networks, making technical experts particularly influential in public policy and city building activities (Seely 1996). We might say that experts served as the "human face" of technological networks, symbolizing the founding tenets of modernity including efficiency, stability, functionality, objectivity, and perhaps most importantly, progress (Hickman 1992).[iii]

The rise of the technical expert in modern societies resulted in a privileged status for those with specialized knowledge. For example, vernacular German includes proverbs expounding the superiority of the engineer, such as *dem Ingeniör ist nichts zu schwör* (no task is too difficult for the engineer), with the engineer serving as a prominent symbol of national identity. The slogan "Made in Germany" was conceived after World War II to tie the nation's future to earlier technical achievements of genius inventors such as Werner von Siemens. In the US, a similar trend occurred at the turn of the twentieth century as the cowboy was replaced by the engineer as the symbol of American culture (Hickman 1992). Thayer (1994: 32) describes the importance of the expert to the collective American psyche as follows:

> We have never lost the myth that technological innovation and invention is America's rightful spiritual territory…Clearly Americans place greater social value upon those people whose occupations involve scientific discovery and technological development than on those who deal with social issues or problems. Starting salaries for engineers are roughly twice those of social workers or teachers.

Today, the most conspicuous technical experts in developed countries include natural scientists and engineers whose specialized knowledge is based on the formal study of a scientific or technical discipline. We can also include other disciplines under the banner of technical expertise, including architects, planners, lawyers, and policy experts. In this chapter, we focus specifically on technical experts in urban contexts–urban planners and designers, civil and environmental engineers, architects and landscape architects–but intend for the discussion to address all forms of expertise that explicitly address scientific and technical issues.

In all of these cases, the social power of the technical expert is derived from a combination of professional status (e.g., engineers and architects), adherence to the scientific method (natural scientists), or simply the mastery of a specialized field of knowledge through formal training (urban planners). The technical expert is differentiated from non-experts by the possession of a "core set" of specialized knowledge as well as an elevated position in society, with non-experts deferring to the expert's superior judgment. As Selinger and Crease (2006a: 230) point out, "The phenomenon of expertise…is ultimately and inextricably tied to its social utility."

While the pursuit of expertise has the social effect of elevating the individual to semi-god status, it comes at the expense of a narrowed perception through specialization.[iv] Experts are celebrated for their microscopic, specialized analysis of problems rather than emphasizing a macroscopic, holistic perspective. As such, it would be antithetical to be considered a 'holistic expert.' Cliff Hague (1997: 4), former president of the UK Royal Town Planning Institute, remarks in this context that:

> Twentieth century higher education and research has been dominated by analysis. Ever more sophisticated ways have been found to break experience down into its constituent parts. New disciplines have been built by reducing scope while deepening, and making more particular, the knowledge and methodologies.

Critiques of Expertise

This sacrifice of breadth for depth seems the logical price to pay for the acquisition of expert knowledge. Such a strategy facilitates the division of labor among different disciplines, a pragmatic approach to dealing with the increasingly complex technical artifacts and systems that comprise contemporary societies. However, the specialized worldview of the technical expert has not gone unchallenged. At the most basic level, the limited perspective of the expert is problematic because of the inability to "see the forest for the trees." As Lane and McDonald (2005: 724) argue, "technical knowledge simultaneously sharpens our focus and obscures our vision." But specialized knowledge has deeper problems beyond its atomistic worldview, four of which we discuss briefly in the following paragraphs.

First, ontological and epistemological critiques of expertise challenge the commonly held assumptions about knowledge generation practices. The ontological assumption of traditional forms of expertise is that of a knowable and unequivocally re-presentable world "out there," the basis of positivist philosophy. Harding (2000: 129) describes this stance as the dream of "one world, one and only one possible true account of it, and one unique science that can capture that one truth most accurately reflecting nature's own order." It follows that there is a universal knowledge free from the shackles of context, its validity and applicability independent of both time and space. In this perspective, knowledge overcomes immanence and rises to the realm of transcendence. Thus, the positivist approach to problem solving, environmental or otherwise, is through the application of universal knowledge. Adherents of universal knowledge tend to adhere to a teleological notion of progress and believe in ultimate solutions that can be discovered by following the "proper path of science" (Moore 2001). Naturally, positivists tend to dislike post-modern and post-structural scholars who argue that science is plural rather than unitary (Harding 2000). Critics of positivism dismiss foundational claims that are universal and ahistorical because they allegedly reduce the world to isolated, discrete and meaningless pieces. Instead, they forward a holistic, pluralistic imagination (Schlosberg 1999, Guy and Moore 2007).

A second critique of expertise is that it relies on a positivist worldview that couples the universality of scientific and technical knowledge with the notion that this knowledge is value-free and neutral. Technical experts tend to be portrayed as objective actors in policy-making activities, transcending partisan interests and 'speaking truth to power' (Fischer 2006; Stilgoe et al. 2006). However, the existence of multiple forms of formal knowledge, and the inherent political character of this knowledge, is readily apparent in environmental conflicts.

The institutional bias toward expert knowledge has been countered by the emergence of counter-experts, individuals who can dispute technical experts on their own terms (Yearley 2000). Arguably the most famous of environmental counter-experts is Rachel Carson, whose writings were highly influential during the founding of contemporary environmental movements. In *Silent Spring*, Carson (1962) relied on a network of researchers and scientific evidence rather than moral arguments to make the case against the indiscriminant use of pesticides in the US (Lytle 2007). Her approach of "fighting science with science" helped to spawn the emergence of counter-expertise in environmental conflicts where a high degree of uncertainty and the presence of conflicting values are both common and unavoidable.

Since the 1960s, environmental NGOs have become increasingly adept at employing counter-experts to muddy the scientific waters through the introduction of competing interpretations of a particular scientific or technical issue. Outside of scientific debates, other technical experts can also serve as counter-experts, as in the case of Jane Jacobs (1961) intervening in master planning efforts in the 1960s. This is not to say that counter-experts are equals to experts but rather that they challenge their authority using equivalent methods and language. For example, competing expert knowledges are frequently marshaled by property developers and nongovernmental organizations (NGOs) to deliberate over the implications of environmental impact assessments.
The rise of counter-experts is a response to the inclination for technical experts to frame technical problems through the eyes of their elite employers (Fischer 2000). Foreman (1998: 60) argues that technical experts in government and corporations become the "perceived handmaidens in science and

technology" and can even work at odds with the public they are ostensibly chartered to serve. In this context, Fischer (2000: 61) notes that the emergence of the counter-expert in contemporary environmental disputes:

> redirects our attention…to the limits of our knowledge…[and] uncertainties [that] have shaken the public's faith in the experts. After having long trusted experts generally, citizens are confronted with the task of choosing which experts to believe and trust.

A third critique of technical expertise points to the existence of experiential, local, or tacit knowledge arising from personal experience and exploration outside the confines of educational institutions and without strict adherence to the scientific method.[v] Thus, multiple forms of *formal* knowledge are joined by multiple forms of *informal* knowledge. Scott (1999: 320) differentiates between formal and informal knowledge using the classical notions of *techne* and *metis* where the former involves "impersonal, often quantitative precision and a concern with explanation and verification," while the latter refers to indigenous knowledge, meaning, experience, and practical results. This distinction is particularly apparent when comparing Western science to other forms of knowledge, with the former being abstract, reductionist, and oriented toward the separation of humans from non-humans (Lane and McDonald 2005). Stakeholders who lack formal knowledge are often portrayed as being "incapable of grasping the technical nuance and methodological complexity of science" (Kleinman 2000: 139). In this regard, Turner (2001: 123) observes that, "expertise is treated as a kind of possession which privileges its possessors with powers that the people cannot successfully control, and cannot acquire or share in."

The recognition of different forms of knowledge by post-positivists highlights the tension between democratic forms of governance and technical expertise. When discussing scientific and technical problems, holders of experiential, local, or tacit knowledge are generally not granted a seat at the decision making table due to an institutional bias toward formal knowledge. As such, the possession of technical expertise has significant political implications by marginalizing those who do not subscribe to a positivist worldview and the primacy of expert opinion. The centrality of the technical expert in political systems is commonly referred to as *technocracy* where technical experts rule by virtue of their specialized knowledge and position in the dominant political and economic institutions. Here, expert knowledge is applied to the task of governance and promotes technical solutions to political problems, with the technical expert assumed to be above partisan politics and an irrational general public (Fischer 1990).

Fourth and finally, there are important practical issues that cannot be resolved through the application of technical expertise. For example, Ulrich Beck (1992) argues that the question of whether we should use nuclear energy can never be answered with an objective "yes" or "no" because issues of risk and risk perception require "soft" and culturally specific responses. Values and politics are embedded in sociotechnical developments and no *pareto optimum* calculation can ever offset a collective preference for caution. This is clearly the case with contemporary scientific disputes over climate change, genetically modified organisms, human cloning, nanotechnology, and the like. A technocratic response to these conflicts is to portray critics of scientific and technical solutions as irrational and the mission of technical experts often becomes one of educating objectors to the "facts" of a particular problem or even ignoring their pleas. However, the idea that solving "wicked problems" by uncovering all of the facts is not only delusional; it can lead to an impasse in decision making due to the lack of data (the common problem of "paralysis by analysis").

Clearly, the contemporary model of technical expertise has numerous problems related to epistemological and ontological issues, objectivity, political power, and practical matters, as summarized above. The deficiencies of the positivist worldview become even more apparent when we consider the notion of sustainability in the following section.

Sustainability as a Challenge to the Primacy of the Technical Expert
Sustainability has multiple meanings and interpretations, although most advocates would probably agree that it involves a holistic approach to solving complex, interrelated, and multi-dimensional problems. Dryzek (1997: 126) argues that the main accomplishment of sustainability has been "to combine systematically a number of issues that have often been treated in isolation, or at least as competitors." Thus, the principal advantage of sustainability is that it takes a pluralistic and inclusive view of problem solving, as opposed to conventional problem solving that limits its focus to particular elements while overlooking unintended consequences as well as the proverbial "big picture."

The conceptual comprehensiveness of the sustainability agenda is, for better or worse, a result of its multidisciplinary genealogy. One of the earliest examples of this holistic form of thinking can be traced to English and German forest management practices in the seventeenth century, as articulated by John Evelyn and Hans Carl von Carlowitz. They argued that one should not harvest more wood than a particular forest yields, instead advocating for a form of steady-state resource extraction. In the nineteenth century, urban social reformers such as Edwin Chadwick extended the degradation of environmental conditions beyond economic management by recognizing the link between poor health conditions of the British working class and urban sanitary conditions. The contemporary notion of sustainability has its roots in these early modern practices that recognize the interrelated quality of seemingly independent problems.

The most widely cited definition of sustainability is attributed to the so-called Brundtland Commission and states that sustainable development "is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987: 43). This broad definition of the concept has proven difficult to translate into practice and many scholars have developed heuristic models to elucidate the application of sustainability. Perhaps the most famous of these is the *Three E* model that describes sustainability as the triad of *E*conomic viability, *E*nvironmental protection, and social *E*quity.[vi] The model is intended to highlight the challenge of simultaneously accommodating a multiplicity of competing demands. In other words, the openness of the sustainability concept to various claims and concerns comes at the price of compromise. Campbell (1996) highlights a crucial implication of this model by identifying the inherent conflicts between each pair of "Es" and the pressing need for strategies to resolve these tensions. From this perspective, sustainability issues involve the management of conflict through a "restless, dialectical process" of open discussion and negotiation (Healey 2004: 95).

Recognizing the importance of negotiation between competing interests reveals sustainability as an inherently political endeavor. Prugh et al. (2000: 7) note that "sustainability is provisional; it is subject to multiple conceptions and continuous revision, the very stuff of politics." Sustainability is also context specific, or as Guy and Moore (2005: 1) argue, it is "more a matter of local interpretation than of the setting of objective or universal goals." Identifying the most suitable political system to facilitate successful resolution of conflicts and the amicable exchange of interpretations then becomes a pressing concern for sustainability advocates (Moore and Brand 2003, Moore 2007). Clearly, then, the conventional model of technical expertise that purports to be objective, apolitical, and value-free is not an ideal fit for political interpretations of sustainability.

Despite the inherent politics of the sustainability charter, the Western world has generally addressed this challenge by relying heavily on technical expertise (see Tate et al. 1998). Technical experts have been tapped to develop more efficient and effective technologies to avoid stakeholder conflicts and unintended consequences, a prime example being the development of renewable energy strategies to replace fossil fuels. This is the underlying message of ecological modernization advocates in Northern Europe and their green business counterparts in North America who argue that industrial society's harmful aspects can be expunged through the application of improved technologies (for example, see Hawken et al. 2000; McDonough and Braungart 2002). The attractiveness of ecological modernization stems from its implicit assumption that environmental and social problems can be overcome without leaving the path of modernization (Hannigan 2006). Thus, sustainability becomes a technocratic endeavor, one that retains power in the hands of the political and economic elites, strengthening the compact between technical experts and their elite employers. As Dryzek (1997: 147) concludes, "in its most limited sense, ecological modernization looks like a discourse for engineers and accountants."

Bäckstrand (2004: 707) is equally critical of ecological modernization because it exacerbates "the dichotomous divide between nature and society, social and scientific knowledge, expert and non-expert knowledge...hence, ecological modernization does not rely on a new conception of science." However, she adds that more radical forms of ecological modernization are possible. Strong, bottom-up notions of ecological democracy that champion public deliberation communication and participation by civil society can serve as an antidote to the technological fix approach of weak or top-down ecological modernization approaches. Bäckstrand and other critics of ecological modernization do not call for the wholesale abandonment of technical expertise but rather contend that technology can be directed by society as a whole rather than imposed from above by powerful elites. Such bottom-up approaches emphasize the creation of political communities to deliberate on conflicts and to transform them via equitable and lasting solutions.

Finding Common Ground between Technical Experts and Sustainability

Those who advocate for the deliberative, bottom-up model of sustainability will likely agree that conventional notions of expertise are not an optimal fit with notions of sustainability. In other words, we should be careful when employing the term *sustainable expert* because of the inherent conflicts between specialized and holistic worldviews as well as the related political issues. Does this mean that there is no such thing as expertise in sustainability? Do we need to abandon specialized knowledge and adopt a holistic worldview that takes into account multiple viewpoints? Is there reason to believe that the technical expert may gradually become an endangered species, as Dreyfus and Dreyfus (1986) fear? We argue that while the fit between technical expertise and sustainability is not ideal, it is far from a hopeless endeavor. Rather than abandoning specialized knowledge outright, we see possibilities for renovating technical expertise to align with the goals of sustainability. In the following paragraphs, we identify four types of expertise that have been employed since the 1980s to reorient holders of specialized knowledge toward more sustainable goals. We label these approaches the *outreach expert*, the *multidisciplinary expert*, the *meta-expert*, and the *civic expert*. Each makes unique and helpful contributions to the renovation of conventional forms of expertise.

The Outreach Expert

One response to the eroding credibility of technical experts has been a call for a more informed and scientifically literate public. This movement, first taken up in the 1980s, focuses on issues of risk and uncertainty in science and technology, and is frequently referred to as "the public understanding of science." The intent has been to improve communication of scientific and technical knowledge to affected citizenry and in turn, to educate the public about the importance of this knowledge (Wynne 1995, Turner 2001). Jamison (2005) argues that "using science and technology appropriately means, for one thing, that we know how to talk about it and that we have what might be called a collectively shared understanding of the relevant science or technology, that is, that we are scientifically literate." Clearly, this is an appealing and desirable model; it would be difficult to argue against a more educated public, particularly with respect to important issues of science and technology.

One way that scientists and technical experts have imparted their knowledge to the public has been through Science Shops that have proliferated in the United Kingdom, the Netherlands, and other Northern European countries (see Irwin 1995).[vii] The concept has also been adopted by several universities in these countries, and we describe these activities collectively as the *outreach model*. We define outreach as "the activity of an organization in making contact and fostering relations with people unconnected with it, [especially] for the purpose of support or education and for increasing awareness of the organization's aims or message" (OED 2007). The model implies that scientific and technical organizations (and universities in particular) should serve as repositories of wisdom, reaching out to those who are implicated in the application of specialized knowledge.

In some circumstances, the dissemination of specialized knowledge can be useful for at least partially resolving the tensions between experts and non-experts. It has the potential to level the knowledge playing field to some degree and open up debate over technical and scientific problems by disseminating shared language and understanding of the problems. As such, it can be an effective strategy for rebuilding trust between the techno-scientific community and the general public. However, this model has significant shortcomings. First, it does little to address existing power differentials between experts and non-experts, and instead falls back on the conventional "sage on the stage" model of modern scientific and technological development. It has a tendency to reinforce paternalistic, positivist notions of expertise where knowledge elites retain a core set of knowledge that they impart on an ignorant public. This approach can be seen as token reform of technical expertise because its sole emphasis is to bring the public up to speed while leaving expert practice unchanged. Furthermore, it implies that the public, through its ignorance of science and technology, is largely to blame for scientific and technical failures, further exacerbating the lack of trust between experts and non-experts. Finally, it continues to adhere to the "truth to power" model of expertise with respect to the public; it talks to the public but does not listen (Stilgoe et al. 2006). Thus, we conclude that the outreach expert model as a necessary but insufficient reform of technical expertise.

The Multidisciplinary Expert

A second option for accommodating and aligning technical expertise with the discursive and political nature of sustainability is to increase the permeability between existing disciplinary boundaries. The notion of "disciplinary silos" is familiar to anyone who has worked in a university setting where scholars in different departments pursue similar problems in parallel rather than collaboratively, due to ingrained disciplinary habits and restrictive institutional and disciplinary norms and structures (Fischer 2006). The pursuit of sustainability research agendas has the potential to transcend these norms and structures by recognizing the overlaps between related disciplines and by initiating collaborative work. The aim here is not to abandon specialized knowledge but rather to improve experts' understanding of their role with respect to other technical disciplines, particularly where commonalities or overlaps exist.

Multidisciplinary expertise can, of course, reside in the individual. For example, the groundbreaking work of physician John Snow in the mid-nineteenth century London to address the problem of cholera is a famous example of an individual employing multidisciplinary expertise. Snow transgressed the disciplinary boundaries of medicine, chemistry, demography, sociology, and cartography to debunk the widely embraced miasma theory as the primary cause of urban disease transmission (see Johnson 2006). Likewise, the father of landscape architecture and urban planning, Frederick Law Olmsted, was a multidisciplinary expert who incorporated issues of functionality, aesthetics, and social needs in his parks and urban designs. He acknowledged the connections between social and environmental problems, although the political and cultural dimensions of his projects tended to be less successful than his engineering and landscape design elements (Spirn 1996).

While multidisciplinarity can be an individual endeavor, we are more interested here in partnerships that are formed by experts from two or more disciplines to address problems of sustainability. The formation of multidisciplinary teams is a common practice in sustainability, as exhibited in the partnership of architect William McDonough and chemist Michael Braungart (McDonough and Braungart 2002) or the collaboration between business entrepreneur Paul Hawken, physicist Amory Lovins, and management consultant Hunter Lovins (Hawken et al. 1999). Collaboration leads to the identification of commonalities and the formation of a new core set related to but independent of the core sets of each individual. Thus, multidisciplinary expertise reinforces the legitimacy and power of expert knowledge through an alliance between two or more core sets of technical expertise.

An example of the benefits of multidisciplinary cooperation is illustrated by activities in the Belgian city of Hasselt in the mid to late 1990s. Located seventy kilometers east of Brussels, Hasselt was plagued by severe traffic-related problems. Engineers proposed a conventional technical solution of building a third ring-road around the city to divert automobile traffic from the historic center. Those trusting in the virtue of individuals argued that the transportation problems could be solved through campaigns to change citizen behavior by encouraging walking, cycling, and public transport. However, the city council chose to ignore both the proposed technological fix and the behavioral fix solution and instead, embarked on a multi-pronged approach to encourage non-automobile forms of transportation. The driving lanes in the inner city were narrowed and hundreds of trees were planted to create a more pleasant and walkable city center environment. Facilities for bicyclists (bicycle lanes, storage sheds, and showers) were introduced along with bicycle pool programs where adults could volunteer to accompany children to school. Another program was established to provide bonuses to employees who cycled to work. Public transport services were increased eightfold and included new bus routes with five-minute intervals and heated rooms for waiting passengers.

As a whole, the multi-faceted planning solution undertaken in Hasselt involved a partnership of public policy, urban design, and engineering experts that created a combination of "hard" infrastructure strategies and "soft" social solutions to form a multi-faceted transportation strategy at several levels. One of the co-designers of these solutions contended that the technical experts initially "made the mistake of only look at the 'engineering' side of it," and went on to argue that the success of the project "is all about a combination of measures, definitely not only by engineers: engineering, mentality, environment, city building, social issues, communication" (Moerkerk 2002).

There are, of course, a number of formidable barriers to overcome in the pursuit of multidisciplinary research agendas including but not limited to jargon, epistemological assumptions, funding protocols, and the portioning of reputational credit arising from joint projects. For example, the politics of "units of assessment" (UoA) as promulgated by the UK Research Assessment Exercise is an example of an institutional structure that creates disincentives to collaborate across disciplinary boundaries. The work of every UK academic researcher has to be allocated to one of the 67 subject-based UoAs and critics argue that this mechanism poses problems for the practice of multidisciplinary research–although the responsible organization denies that this is the case (HERO 2002).

Similar to the previous model of the outreach expert, the multidisciplinary expert has merit but again fails to question the idea of a core set of specialized knowledge being retained by technical experts. Sustainable problem solving remains in the elitist province of the alma mater and does not challenge the boundary between experts and non-experts. Also, the multidisciplinary expert continues to promote technocratic approaches over the inclusion of tacit and experiential forms of knowledge.

The Meta-Expert

Taken to its extreme, the preceding notion of the multidisciplinary expert begins to resemble an entirely new class of expert that we label here the *meta-expert*. The role of the meta-expert goes beyond disciplinary collaboration and is dedicated to juggling the sundries of multiple specialized knowledges and, in effect, acting as a broker of technical expertise. Meta-experts are generalists with a clear understanding of what specific disciplines can and cannot contribute to problems of sustainability. They do not subscribe to a core set of knowledge but rather have the license to "pick cherries"–they are unabashed "eclecticists" who have the skill to translate across different clusters of expertise. As such, meta-experts act as interdisciplinary brokers, developing specific solutions through the synergy of multiple core sets of knowledge.

An example of meta-expertise is evident in sustainable building practices that have emerged in North America and Northern Europe in the past decade. In sustainable building projects, the building owner or developer hires a sustainable building consultant to facilitate brainstorming sessions or charrettes with project team members and identify synergies between different building strategies. For instance, the meta-expert might recognize the multiple benefits of designing the project with a green or vegetated roof (insulating properties, increased roof life, stormwater runoff, aesthetics, etc.) and then coordinate the strategy by facilitating discussion and design between the various project team members (architect, mechanical engineer, structural engineer, landscape architect, and civil engineer). The sustainable building expert recognizes that sustainability strategies are multi-valent and have numerous intended and unintended implications for the project as a whole. In the above example, the green building consultant might recognize how the green roof strategy could interfere with other project goals such as rainwater harvesting, a daylighting approach that relies on roof skylights, or cost limitations. By identifying these conflicts in advance, the meta-expert can initiate dialogue among the team members to decide on the optimal strategies to pursue.[viii]

Meta-experts adhere to the ontological assumption that sustainability is neither a problem of simplicity nor a problem of disorganized complexity but rather a problem of "organized complexity" (Jacobs 1961). Under the first model, cause-and-effect chains can be fully explained, and thus, solved by formulaic management rules. Under the second model, these chains are too complex to be fully described and can be tackled only with stochastic evaluations of previous interventions. The third model as followed by meta-experts recognizes that patterns can be understood but not by a sole individual. As such, technical expertise consists of "situated knowledges" and solving problems requires the pooling of knowledges to develop a shared asset base. The purpose of the meta-expert is to identify potential linkages and facilitate their co-discovery by mediating between different technical experts.[ix] Unlike the multidisciplinary expert who retains a core set of specialized knowledge, the meta-expert coordinates many core sets to devise a meta set of knowledge. Cliff Hague (1997: 4), former president of the UK Royal Town Planning Institute, argues that planners are reasonably well equipped to play the role of the meta expert because "town planning…has [always] prioritized synthesis over analysis. Planners have been magpies across the disciplines, picking relevance where they found it." One could also imagine public policy experts, sociologists, anthropologists, and geographers being particularly well positioned for such roles.

The Civic Expert

The previous three models of expertise have advantages over traditional models of expertise because they improve non-expert understanding of scientific and technical knowledge (the outreach expert model) or increase communication and collaboration between experts (the multidisciplinary expert and meta-expert models). However, none of these models systematically challenges the privileged status of expert knowledge or attempts to engage in a substantive manner with non-experts. In other words, they do not challenge the technocratic mode of decision-making and fail to require that technical experts also *listen* to the so-called non-experts. Brand (2005b: 19) describes these seemingly ordinary individuals as the "ultimate experts in user behavior" because they literally create everyday conditions.

John Dewey advocated for new forms of collaboration between experts and the public as early as the 1920s, arguing that, "The man who wears the shoe knows best that it pinches and where it pinches, even if the expert shoemaker is the best judge of how the trouble is to be remedied." (Dewey 1927/1954: 207) The attitude towards experts as first suggested by Dewey, William James, and other American Pragmatists, has more recently been forwarded by advocates of civic environmentalism such as DeWitt John (1994) and William Shutkin (2000). Here, a number of informal expertises (experiential, local, tacit, and indigenous) are also perceived to be valid. The acknowledgement of a plurality of expert knowledge challenges what Bruno Latour (1987) refers to as "science-as-institution" by admitting other actors to scientific and technical decision-making processes. This is not a direct assault on the conventional technical expert but rather a call to enrich science and technological decision-making by embracing a wider range of expert opinion (Stilgoe et al. 2006).

To accommodate ideas of tacit or experiential knowledge, and to facilitate two-way communication between experts and non-experts, we introduce a fourth category of expertise, the *civic expert*. Civic expertise revolves around participatory models of specialized knowledge and highlights the social contingency of technological endeavors by eliciting critical reflection on social circumstances and needs, and allows for the transparent and accountable recognition of non-focal technological consequences (Sclove 1992, Bäckstrand 2004). For example, new models of scientific debate that have emerged in Northern Europe in the last decade over genetically modified foods and nanotechnology represent a softening in the stance of experts and a new relationship with the public that replaces passive acceptance for interested partnership (Stilgoe et al. 2006). From this perspective, the top-down authority of the expert involved in technocratic forms of politics is replaced by democratic politics where experts and non-experts function as collaborators or partners in problem solving. This arrangement does not guarantee an equitable distribution of power between stakeholders but at the very least, allows for the possibility that non-expert voices can be heard.

A number of promising techniques have been developed to advance the notion of civic science and expertise, including constructive technology assessment, strategic niche management, citizen panels, and the *L'Eprouvette* initiative at the University of Lausanne.[x] The intent of these approaches is to open policymaking procedures to actors other than technical experts by including citizen voices in scientific and technological debates (see Rip et al. 1995). Schot and Rip (1996) refer to these processes as "second-order learning" that involve critical reflection upon the assumptions that underpin the pursuit of factual and technical first-order learning. The involvement of citizens in technical decision-making broadens expertise by not only asking question of "how" but also of "why".[xi] These notions of civic expertise have been adopted by a wide variety of STS scholars including Arie Rip, Richard Sclove, Sheila Jasanoff, Brian Wynne, and Steve Fuller, among others.

Civic expertise is not only a policy model but can be project-oriented and hands on. An example of civic expertise in architectural practice is the emergence of design/build practices since the 1990s that involves service learning and project-based education. The most widely known design/build program in the US is the Rural Studio at Auburn University in Alabama, founded by Samuel Mockbee and Dennis K. Ruth in 1992. This approach has spread to several other architecture schools, notably the University of Virginia, the University of Washington, and the University of Texas at Austin. The purpose of design/build is to increase the public role of the architect through advocacy and engagement with underserved communities. Design/build programs combine community outreach, formal education, and architectural design and production through a one- or two-semester engagement in a small building project such as a house or community center. The technical expert (architecture professor) acts as the moderator between the experts-to-be (architecture students) and community members, resulting in "a mutual exchange between the designer and the client, and in the best cases, a mutual benefit to both. Through a participatory process these benefits are defined, clearly understood by all, and mutually sought" (Bell 2004: 13). Architectural design thus becomes a democratic process of negotiation between all interested parties.

The idea here is that public engagement in scientific and technological development needs to move upstream, rejecting the "end-of-pipe" model where the public is reactive to the consequences of science and technology and instead, makes transparent the assumptions, values, and visions that drive science in the first place (Wilsdon and Willis 2004). Proponents of civic expertise argue that this mode is not antithetical to science and technological development. Indeed, the spirit of science is skeptical, exploratory, and uncertain, with the practices of peer review, publication, and argument being a foundational practice in the scientific and technical communities, if only to a select group of the community. Advocates of civic science argue that new questions about scientific and technological development are not a threat but rather an opportunity to develop better scientific and technological solutions. As such, experts should be "on tap, not on top" (Stilgoe et al. 2006).

Nowotny et al. (1999) argue that it is only through participatory, discursive, and multifaceted approaches that science can become socially robust and accountable. The civic expertise model is the point where practical considerations about the feasibility, acceptability, and efficacy of technological interventions for sustainability converge with the normative call for the democratization of technology (see Sclove 1995, Fischer 2000). Civic expertise is a significant departure from conventional technical expertise, relying on the notion that "the rules for [the] *production* of scientific [and technical] knowledge will have to change in order to enact civic science" (Bäckstrand 2003: 34, emphasis added). This approach is related to Mode 2 Science as proposed by Gibbons et al. (1994) by involving non-experts through transdisciplinary practices such as citizen juries and consensus conferences.

Similar to the meta-expert model, an existing group of technical experts are aligned towards a civic mode of expertise. Forester (1999: 143) describes the role of participatory planners as follows:

> In cities and regions, neighborhoods and towns, planners typically have to shuttle back and forth between public agency staff and privately interested parties, between neighborhood and corporate representatives, between elected officials and civil service bureaucrats. They do not just shuttle back and forth though. Trying to listen carefully and argue persuasively they do much more. They work to encourage practical public deliberation–public listening, learning and beginning to act on innovative agreements too–as they move project and policy proposals forward to viable implementation or decisive rejection.

The civic expert model moves beyond the ecological modernization version of sustainable development and frames knowledge generation as a socially distributed phenomenon that includes experts and non-experts alike. The goal of the expert is not to generate reliable knowledge validated by disciplinary peers but to develop robust knowledge from socially distributed expertise (Nowotny et al. 1999; Bäckstrand 2004). Robust knowledge emphasizes the processes of knowledge generation rather than the end product of these processes (Nowotny 2003). The ultimate benefit of the civic expertise model and the increased input of non-experts is the potential for improved decision making via "the intelligence of democracy" (Lindblom and Woodhouse 1993). Searching for agreement among multiple stakeholders allows for the acknowledgement of the polyvalent nature of science and technology and enlists stakeholders in the process of characterizing and considering a technology's social implications (Sclove 1992).

As a whole, the practice of discursive technological development suggested by the civic expertise model is the most ambitious proposal outlined here. However, it faces specific and particularly significant barriers including entrenched power relations as well as a lack of familiarity and experience with deliberative practices among all involved parties, experts and non-experts alike. Likewise, there is a significant epistemological difference in that knowledge emerges from deliberation rather than being imparted by the technical expert on non-experts. It should be no surprise that these more democratic forms of technological development have emerged in political cultures such as Denmark and the Netherlands where citizen participation in political decision making processes is encouraged and commonplace. However, participatory technological policy-making continues to be an exception to the rule even in these countries, highlighting the formidable challenges to expanding scientific and technological debates to include the general public.

Towards an Ecosystem of Expertise

Table 1 provides a summary of the four models of expertise described above. The models can be differentiated by their epistemological and disciplinary assumptions, their attitudes towards other experts and the public, and how they envision the flow of technical knowledge. We have argued elsewhere that these models as a whole comprise an *ecosystem of expertise* where different niches are filled by different interpretations of what it means to be an expert in sustainability issues (Brand and Karvonen 2007).

There are clearly merits to each approach and a general conclusion we forward is that, at this early stage in the development, it is not important to determine which model is most effective. In other words, each of these models should be welcomed because it challenges traditional roles of the technical expert in different ways. Each model encourages holders of specialized knowledge to

Table 1 Four models of expertise to address sustainability

	Outreach Expert	*Multidisciplinary Expert*	*Meta-Expert*	*Civic Expert*
Cliché role	"The educator"	"The good neighbor"	"The broker"	"The democrat"
Epistemological assumptions	Core set of scientific principles	Overlap of disciplinary core sets	Cherry-picking and syngerism of core sets	Emergent from discourse
Disciplinary assumption	Mono-disciplinary	Multidisciplinary	Interdisciplinary	Transdisciplinary
Attitude toward other experts	Competitors	Potential collaborators	Necessary collaborators	One of many sources of knowledge
Attitude toward the public	Receivers of expert wisdom	Not considered	Not considered	Partner in generating solutions
Knowledge flow	Top-down	Lateral	Lateral and discursive	Multi-directional and discursive
Role of power	Competition between disciplines for the exclusive claim to truth	Defined by overlaps between disciplines	Emergent from collaboration between disciplines	Shared and contested between experts and non-experts
Example	Science Shops	Hasselt transportation	Sustainable building consultant	Design/build programs

consider their multiple roles as experts, citizens, and participants in democratic politics, to assess their individual strengths and weaknesses, and determine how to orient their work and allegiance towards one or more of these models. For example, those of us who are better at collaborating with other experts should do so while those of us who are better at communicating with the public might choose the Outreach Expert model or the more aggressive Civic Expert model. We recognize that such a pluralist attitude towards expertise is an idealized perspective whose implementation will face numerous hurdles in terms of institutional incentives, vested interests, power gradients and so on. We describe these modes of expertise in the hope of arousing debate among practitioners and theorists of sustainability as an invitation to strategize on methods to overcome these barriers.

However, an important question that lurks in the background of this framework is the motivation for technical experts to change their attitudes and orientations towards other disciplines and the public. Why should experts sacrifice their relatively privileged social position? Three points come to mind that may make these models more appealing. First, the models of expertise presented above can potentially help to reverse the erosion of trust between experts and the general public. Sustainability problem solving can be seen as a way to bridge the gulf between those with specialized knowledge and those who are implicated in the application of this knowledge.

Second, the quest for more sustainable solutions can appeal to the problem solving disposition shared by most, if not all, technical experts. The promise of more socially acceptable and, in essence, more effective solutions is worth the work required in renovating existing scientific and technical approaches to problem solving. And finally, there is an ethical dimension to expertise. With professionals such as architects and engineers, ethics is embodied in their commitment to serve society and thus, new models of expertise offer a way to fulfill their social contract. For non-professionals, an ethical argument cannot rely on the professional's social contract but can appeal to the citizen within the technical expert. We leave these normative dimensions of expertise for future study but recognize that this is perhaps the most formidable barrier to adopting these models.

In conclusion, we venture two challenges to all technical experts. First, it is important to maintain a bird's-eye view on the system and resist the temptation of adopting old or new claims of exclusivity. There are advantages to all of the different niches that these emerging models of expertise offer and the goal of experts should be to appreciate these different niches and seek strategic collaborations and new modes of practice. Second, a formidable barrier to the further development of these modes of expertise is the institutional barriers that inhibit multidisciplinary, interdisciplinary, and transdisciplinary collaboration. There is a need to lobby for the dissolution or at least lowering of these barriers if sustainable approaches to scientific and technological development are to become widespread. The former is an individual challenge, the latter a political one.

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i This chapter is a revised version of an article that was published in *Sustainability: Science, Practice, and Policy* (see Brand and Karvonen 2007).

ii Another emerging discourse on expertise has been introduced by philosophers of science. Harry Collins and Robert Evans call this discourse "Studies of Expertise and Experience" and emphasize a core set of knowledge held by experts (see Collins and Evans 2002, Collins and Evans 2007, and Selinger and Crease 2007a). This is a markedly different interpretation of expertise when compared to STS scholars who question the legitimacy of knowledge claims made by technical experts (for an extended critique of Collins and Evans, see the June 2003 issue of *Social Studies of Science*).

iii For a helpful discussion of progress as it relates to scientific and technological development, see Marx 1999.

iv With respect to specialization, it is often joked that experts know more and more about less and less until they know everything about nothing (Stilgoe et al. 2006).

v Those with tacit knowledge have been referred to as 'lay experts' but we avoid this term due to its internal inconsistency (see Collins and Evans 2002; Stilgoe et al. 2006).

vi This model is also referred to as the Three P model (people, prosperity, and planet) or the Triple Bottom Line.

vii The US has no equivalent model of Science Shops, although the National Science Foundation attempted to support similar activities through its 'Science for Citizens Program' in the late 1970s (Fischer 2006).

viii The meta-expert approach to sustainable building has been codified in programs such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) and the Building Research Establishment's Environmental Assessment Method (BREEAM) (see www.usgbc.org and www.breeam.org).

ix Biologist E.O. Wilson (1998) describes the synthesis of knowledge using the term 'consilience' and advocates for finding common ground for explanation between humanities and sciences. We are encouraged by his call to bridge disciplines although we disagree with the inherent positivist assumptions in his argument.

x See Labo "L'Eprouvette" at http://www.unil.ch/interface/.

xi Habermas (1973) makes a distinction between *Verfügungswissen* and *Orientierungswissen*, the former refers to the knowledge related to how to do stuff (the general domain of natural scientists and engineers) while the latter refers to knowledge about whether or why to do stuff (typically the realm of social scientists).