

Democratic Expertise:

Integrating Knowledge, Power, and Participation⁽¹⁾

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"No lesson seems to be so deeply inculcated by the experience of life as

that you should never trust experts." - Robert, Lord Salisbury (1877)

Successful environmental policies often emerge in the presence of favorable technical conditions that help to structure problems and, indeed, help to solve or substantially ameliorate them. In the chlorofluorocarbon case, such favorable conditions included the availability of scientific techniques allowing laboratory experiments on chlorine-catalyzed ozone destruction and (later) detection of the ozone hole, the timely invention of the Aplanalp valve as a replacement for CFC sprays, and especially the technical "sweetness" of the organic chemistry and engineering which allowed Dupont and other chemical manufacturers relatively quickly and inexpensively to shift to non-CFC coolants as replacements for Freon. There still were many questions about the severity and mechanics of the ozone-depletion problem, coupled with ample political-economic opposition to government restrictions in most nations. But technical expertise in its own right did much to help resolve the usual struggles involving knowledge, power, and participation, leading eventually to the Montreal ozone protocol.

This was a prototypical example of a "technological fix." The technology was sufficiently developed, appropriate expertise was available, and requirements for governmental financing were negligible. Unfortunately, such favorable conditions are hardly the norm in complex technological decision making. Environmental problems frequently are ill-structured, wicked, or otherwise difficult even to define in ways that bring into alignment the congeries of affected interests, partisan perceptions, and diverse expertises negotiating to co-construct the definition of the situation (Hisschemoller and Hoppe 1996). In difficult situations of this type, if "politics" does not completely eclipse technical expertise, what role can expertise play in constructive policy making? How should experts and users of expertise orient their efforts so as to structure problems and evolve sensible policies?

Of the many variables that help to explain why some environmental cases turn out fairly well and others do not, we will argue that an especially important one is *democratic expertise*. Such expertise is not fully developed, diffused, and employed in contemporary political systems; it is as much aspiration as achievement. But environmental problem solving appears to benefit substantially even from levels of democratic expertise that are moderate compared with what we hope will someday become possible. Democratic expertise, it turns out, is something of a

philosopher's stone; it has the capacity to transmute conflicts among knowledge claims, power holders, and a seemingly impossible diversity of partisan belligerents into relatively intelligent and fair collective problem solving.

There are many different types and arenas of expertise, of course. Some are suitable for individual craftspersons, some for huge industrial equipment, others for financial accounting in large organizations. We are not trying to understand all forms and facets of expertise, just those aspects of the subject that need to be understood in order to work out acceptable, sensible agreements in the political realm. Seeing clearly what is problematic about expertise in politics requires starting from what is problematic about politics more generally. An essential feature of democracy is contestation among differing partisans, each of whom sees the public interest somewhat differently. Political participants draw on information and analysis - both to help understand their own needs and aims, and to help persuade others to lend support or withdraw opposition. Reasoned persuasion clearly is not the dominant influence in political life in every instance, but better environmental problem solving surely requires better thinking and better negotiating by political participants. Unless expertise is adapted to the realities and tasks of the semi-democratic politics now practiced, it is unlikely that knowledge professionals will make anywhere near an optimal contribution to political practice.

To develop this argument, we first review a number of the shortcomings of expertise as applied to political life, paying particular attention to problems of values, bias, and uncertainty. We then analyze ways of coping with those shortcomings, focusing on targeting of expertise to assist conflicting partisans, promote social learning, and otherwise move away from unintelligent responses to environmental problems.

SHORTCOMINGS OF EXPERTISE⁽²⁾

If conventional thinking about expertise were distilled into a coherent story, it would run something like this: Because most citizens have too little information, skill, time, or motivation to understand the details of nuclear fusion, EPA budgets, or tradeable pollution permits, citizens therefore delegate decisions about these matters to elected officials, who set general policy based on negotiations with each other and with relevant interest groups and businesses. Administrative agencies handle the details. Throughout this process, technical experts employed by business, government, and interest groups are thought to provide advice on factual matters and techniques, leaving value judgments largely to others. Consumers, who know very little about the particulars of designing, producing, transporting, and disposing of goods, likewise delegate many economic decisions, but then "vote" with dollars or rupees for items they desire from the mix of those available in the market. Thus, business executives and consumers, government officials and citizens decide what is to be done, while technical professionals are hired to do the R&D, design production machinery, and otherwise provide necessary supporting techniques regarding how to do it.

Existing in disorganized fashion in many minds, this stylized schema might be called the simple theory of expertise, simple because it operates unproblematically: labor is divided neatly between experts, government officials,

business executives, and others; tasks are accomplished straightforwardly without uncertainties or inaccuracies; each participant can play his or her role effectively. (Woodhouse and Nieuwma 1997, p. 24)

Attempting to put this approach into practice, progressive-era reformers created independent regulatory commissions and other governmental innovations to insulate neutral expertise from the corrupting influence of politics. Such hopes continue into the present, as when environmental risk professionals perceive a public swayed by emotionalism and ignorance pressuring elected officials to enact expensive and ineffective remedies. Supreme Court Justice Stephen Breyer, for example, recently advocated creating an expert corps of civil servants - who, somehow, would be completely insulated from politics - to make decisions on how to manage risks (Breyer 1993).

The simple theory was never an adequate description of the interplay among elite power holders, ordinary citizens, and knowledge professionals, of course, but it perhaps had more plausibility prior to the 1960s than in recent decades. Controversies over siting of hazardous facilities, televised disagreements among expert witnesses in the courtroom, and myriad other evidence that experts do not have the answer and may be in the pay of one's opponents have made it good deal more difficult to endorse a naively optimistic view of expertise (Williams and Matheny 1995, Koehn 1995).

Deficiencies of the simple model long have been apparent. Max Weber was hardly the first to speak of the "naive optimism in which science - that is, the technique of mastering life which rests upon science - has been celebrated as the way to happiness. Who believes this? - aside from a few big children in university chairs or editorial offices" (quoted in Topf 1993, p. 103). "All professions are conspiracies against the laity," George Bernard Shaw said in 1906, speaking through one of his characters. Political scientists looked askance at some Progressive ideas and actions: "We must ceaselessly remember," wrote Harold Laski in 1931, "that no body of experts is wise enough, or good enough, to be charged with the destiny of mankind" (quoted in Bernstein 1955, p. 120). Studying why independent regulatory commissions had not lived up to early hopes, Bernstein concluded that far too much had been expected from experts (and far too little from politics). Expertness can be helpful, he believed, only when:

(a) the scope of the problem is narrow;

(b) the task of collecting data and analyzing facts is difficult and complex;

(c) discretion is severely limited;

(d) the task involves the application of settled policy ... and does not concern the formulation of basic regulatory policy; and

(e) ... the public interest [is defined] with sufficient clarity. (1995, p. 117)

As defects in the simple theory of expertise became increasingly obvious - through everyday experience and scholarly investigations - many people overreacted and shifted toward a

second, more cynical view of expertise that fits with their negative images of big business, bureaucracy, and elected officials. One element of this cynicism is a despair of ever getting a straight answer from professional experts; as a former U.S. senator put it, "I wish just once some scientist would come in here and tell us whether or not nuclear power is or isn't safe" (Pastore 1973). Noting that many experts disagree with each other and that they tend to align with their client's or organization's stance, some people jump to the inference that statistics can be made to say anything and that most experts are venal. The result, according to the cynical theory: Expertise serves only the affluent and powerful.

Some social scientists come close to accepting the cynical theory, albeit in a more subtle form. They point to the fact that many scientific claims can be deconstructed if the stakes are high enough and sufficient resources are devoted to finding ambiguities in research methods or interpretations. The regularity with which this happens in high-stakes political controversies can be interpreted as casting doubt that science ever really can provide guidance on complex policy questions (Collingridge and Reeve 1986).

Most who study expertise-in-action are skeptical more than acclamatory of government-by-expert, a stance we share. But the role of expert knowledge as an aid to action is more complex and sometimes more favorable than cynics would expect (Weiss 1977, Lindblom and Cohen 1979). Moving beyond the cynical theory of expertise without reverting back to the simple theory requires directly confronting and transcending two key shortcomings of expertise as an aid to democratic politics: 1) Expertise is imbued with values; it is not and cannot be objective, neutral, or disinterested; 2) Uncertainty radically constrains expert guidance on complex public issues.

Recognition of Values and Bias

Technoscientists' claims of neutrality and disinterestedness simply do not stand up to scrutiny. While they may attempt to persuade others (and themselves) of what they call "objectivity" in order to promote their own interpretations of problems or solutions, such an Olympian standpoint is not achievable. Most nuclear power engineers, for example, became experts not on nuclear power generically, but on large light water reactors, and either did not know or failed to point out at crucial junctures that there were many other ways to convert fission energy into electricity, some of which might have been far more acceptable politically, psychologically, and economically (Morone and Woodhouse 1989). Much of the global dam-building industry suffered from a "build-it" mentality, frequently failing to account for the indirect effects of dams on downstream populations, systematically overestimating irrigation benefits, ignoring geological and hydrological doubt about the feasibility of damming particular locations, and otherwise (in retrospect) demonstrating thoroughgoing bias in the advice about dam projects rendered to the World Bank and to relevant governments (McCully 1996).

Disinterestedness rarely is realistic, we have come to recognize, in part because "purportedly 'disinterested' advice may be influenced by professional, economic, or political considerations" (Martin and Richards 1995). More generally,

Good science is not a commodity that courts can conveniently shop for in some extrasocial marketplace of pure knowledge. There is no way for the law to access a domain of facts untouched by values or social interests. Scientific claims that are imported into the legal process are colored not only by the interests of the offering parties but also by the social, cultural, and political commitments of other actors in society: for example, the reluctance of experts to breach disciplinary solidarity, the law's desire to cloak morally difficult judgments with the "objective" authority of experts and instruments, and the public's demand for decisions that seem both open and rational. Historically, sociologically, and politically, the proposal that courts should increase their reliance on a value-neutral mainstream science is therefore extremely problematic. (Jasanoff 1995, 207)

Technological controversies such as the siting of electric power plants entail elaborate debate about factual issues, often masking the underlying values that are the essential bases of conflict - such as whether my town or yours ought to suffer the impacts of a major locally unwanted land use (Frankena 1992). Beyond interests, we take values also to include perspectives, cultural assumptions, and ethical commitments.

Science and technology studies scholars have shown the myriad ways in which values are built into supposedly objective, detached technoscientific claims (Longino 1990, Collins 1985, Bloor 1976). They have shown how technoscientific experts have attempted, often successfully, to gain public trust and deference through their rhetoric of neutrality (Wynne 1995). They have shown how expertise is employed as a political resource, often disadvantaging certain groups relative to others (Sarewitz 1996, Harding 1993). By exposing the inherently social nature of expert knowledge, they debunk the possibility of detached, objective advice (Restivo 1994, Aronowitz 1988, Fleck 1979 (1935)). Therefore, competing interests play out in expert knowledge not only through overt exercises of power and decision-making authority, but also through implicit values and unconscious allegiances.

Political scientists have never been very worried about the value-laden character of knowledge per se, taking it for granted and assuming that the problem can be addressed adequately if diverse biases cancel each other out in a sufficiently pluralistic decision-making process. The point, in other words, is not whether values are present in expert knowledge - of course they are - but whether some people's values are systematically over-represented through access to and representation by expertise, while others' are systematically under-represented.

Structural Bias

If knowledge claims are not neutral, the key question becomes: Do certain social interests and perspectives tend *disproportionately* to get encoded in expert knowledge as presently developed and diffused, and who thereby is served? The problem of bias resides not so much in shortcomings of the individual expert, but rather in the aggregate outcome of *whose* values get encoded into expert knowledge and into the activities such knowledge facilitates.

For starters, we know that expertise has become a well recognized resource in political combat:

With well-developed capabilities to counter the arguments of opponents and multiple opportunities for exerting pressure, U.S. interests quickly learn that expertise is a vehicle, rather than a substitute, for political persuasion.

The overriding issue in the American context is not whether expertise detracts from political processes, but how it is harnessed and steered to serve some political interests over others. (Brickman et al. 1985, p. 179)

There is some difference of opinion about which interests have the upper hand in various arenas of politics, in various nations, in different eras, but a modal view in the scholarly literature runs something like this: Legitimate dissents within many fields of expertise and policy not infrequently are squelched, in part because members of the organized professions, while looking out for their own interests, tend to serve those with money and authority much more than they do those with less social, political, and economic power (e.g., Freidson 1986).

Professionalized expertise in the twentieth century arguably has become captured to an indefensible extent by large organizations and by the elites who run them and benefit disproportionately from them. "Expertise has joined money as a major obstruction to democratic decision making, and professionals have gained the high moral ground in claiming legitimate authority" (Derber et al. 1990, p. 206). Some observers refer to the interpenetration of technical expertise and political-economic authority as "technocorporatism" (Fischer 1990), perceiving many engineers and other technical professionals as tending to be "skeptical and even hostile toward politicians and political institutions" (Putnam 1977, p. 385).

Some analysts think that citizens are pretty shrewd in recognizing these realities, but do not have sufficient political power to mount effective opposition (Wynne 1995); others see citizen inquiry and perception as being considerably impaired by elite-dominated socializing institutions, particularly the business sector, and doubt that most people understand anything like the extent to which they are being deceived, manipulated, and outmaneuvered (Lindblom 1990).

Knowledge professionals, too, are subject to these forces, not infrequently becoming caught up in the assumptions of the organizations dominating policy domains, as did most fish biologists who unwittingly conspired to build gimcrackery fish ladders for the Bonneville Power Authority and other business development interests, and thereby helped ruin the very salmon spawning grounds in the Pacific Northwest that they were striving to protect (Black 1995). Too seldom do we encounter clear exceptions to such expert collusion, such as the case of Danish wind-turbine research and commercialization, where a bottom-up R&D process focused successfully on small-scale power generation, driven not by professionals working with oligopolistic organizations but by enthusiasts who cared about advancing a form of renewable energy in line with their environmental values (Jorgensen and Karnoe 1995).

Recognition of Uncertainty

Another impetus for declining faith in expertise is the increasing recognition that expert knowledge cannot eliminate uncertainties concerning complex public issues. Not only are there ambiguities and controversies about environmental conditions per se; even less amenable to scientific answers are questions concerning which regulatory steps will lead to which consequences, at what financial expense, and with what side effects on jobs and communities.

Moreover, many elected officials and other political participants must adapt their substantive problem-solving efforts to strategic maneuvering by others, a task on which formal expertise is of little use (Jelsma 1995).

Some questions about environmental conditions can be formulated in conventional scientific terms, moreover, but actually are beyond the capacity of science to answer definitively - 'trans-scientific' problems in Weinberg's (1972) terminology. And there often are "significant uncertainties in the existing body of scientific knowledge, of a kind which cannot be resolved within the time-frame of decision-making," as manifested, for example, in controversies over scientific advice on permissible radiation doses (MacGill 1993, p. 62). For most environmental and health concerns, therefore, decision making must occur despite high levels of scientific uncertainty. "The process of identifying carcinogens, in particular, is fraught with uncertainties that can only be bridged through the exercise of combined scientific and political judgment. Despite decades of well-funded research, the etiology of cancer remains imperfectly understood" (Brickman, et al. 1985, p. 187). Science and policy regarding global warming likewise are

replete with uncertainties and the prospect of an indeterminate and indeterminable future. Despite or possibly because of this contemporary prevalence of uncertainty there is a general clamour for proof: insistence on certainty and 'proof' for situations characterised by indeterminacy, unpredictability and multiple time-lags is central to much of the political complacency about environmental problems. (Adam 1996, p. 97)

Does all this uncertainty ruin the utility of expert knowledge? Obviously it does not in endeavors such as putting satellites into orbit, brain surgery, and etching microprocessors. Contributions by knowledge professionals to democratic politics may call for a very different sort of assistance, however, and Harvey Brook's term "science for policy" aside, we have no clear mental categories to separate democratic expertise from other varieties of it. As a result, misled by stunning achievements in certain realms of technical practice, experts and users of expertise alike tend to concentrate their hopes and resources on turning up facts that can make uncertainty disappear in more complex arenas of public policy. But when the range of legitimate disagreement can be narrowed, it rarely is narrowed sufficiently to be of much practical use. Thus, after two decades of intensive research, a majority of atmospheric scientists remain about where they started: believing there will be climate warming from combustion of fossil fuels and release of other greenhouse gases, but disagreeing regarding how much warming, how soon, and what should be done about it (Nordhaus 1994).

We now know that this is not an aberration. Scientists and other experts never eliminate uncertainty on sufficiently complex sociotechnical issues, virtually every contributor to the scholarly literature agrees (see especially Collingridge 1983, Collingridge and Reeve 1986). In fact, advances in knowledge often open up vast new arenas of disputation (Lindblom and Cohen 1979), as may now be occurring in regard to disruptions of endocrine systems and declining amphibian populations (Colborn et al. 1996).

RETHINKING EXPERTISE

Recognizing the problems of bias and uncertainty in expert knowledge applied to semi-democratic politics, and recognizing as well the tendency of many technoscientists to work harmoniously with and for political-economic power holders, more than a few thoughtful observers believe we are witnessing a marginalizing of democratic politics. "Economic and political guidance becomes more a problem of planning and management than an issue for public deliberation and, as such, is seen as a job for which only the experts are uniquely equipped" (Fischer 1990, p. 16). Even if technocrats do not become powerful, even if the usual political-economic elites remain the real power holders, ordinary citizens and even relatively sophisticated political activists may well be disempowered partly via the agency of expert-dominated discourse (Laird 1990).

The institutionalized structuring of expert-mediated power wielding by now has penetrated most nooks of technological society, and there is no simple recipe for undoing or redoing it. A nontrivial part of the task, however, surely is the straightforward pragmatic one of recasting our expectations about expertise. To cope better with the limitations of expertise, while making good use of what it can offer, users need to learn how to play their roles better, including becoming more adept in the questions they direct toward experts; and experts need to develop a more sophisticated understanding of how they can best fit into complex problem solving that draws on, but goes beyond, their professional knowledge. Having those who care think straight about appropriate democratic expertise will not solve the problem of what to do about political opponents who now utilize expertise unfairly and inappropriately; but thinking straight ourselves is probably a co-requisite for fighting those battles.

Counteracting Bias

If expert knowledge is not and cannot be value neutral and objective, and if, therefore, there is considerable risk that expertise will be deployed unfairly in ways that disadvantage some of those affected by social choices, what might be done to ameliorate the frequency, magnitude, or perniciousness of biased expertise?

One extraordinarily challenging answer can be discerned from the practice of social movements: More people need to get busy learning what they need to know to minimize reliance on experts. In the realm of health and medicine, this means taking charge of decisions about one's own body, as did groups of people from the women's health collective responsible for *Our Bodies, Our Selves* to the aging white males who presently are rejecting physicians' advice about radical prostate surgery. In the peace movement, it meant activists learning enough about deterrence theory to debate with elected leaders in arguing reconsideration of the European response to American strategic nuclear policy that had stationed Pershing missiles in Germany (Breyman 1998). In the labor movement, it meant union members learning enough about workplace technologies to participate effectively in shaping innovations affecting working conditions (Cherkasky 1995). In the environmental movements, becoming more expert

meant conducting "popular epidemiology" to trace health effects of hazardous waste and drinking water contamination pathways (Brown 1993).

As attracted as we are by the idea of orienting expertise toward citizen empowerment, many forms of specialized knowledge are bound to arise in a society with extreme divisions of labor. Ignoring specialized knowledge may promote a sort of equality but will not systematically promote intelligent decision making. If there continue to be specialized committees at the National Academy of Sciences and in the regulatory agencies, if congressional and courtroom testimony remains disproportionately the province of certified experts, if think tanks remain influential, and if expertise remains in other respects a resource whose deployment requires access or funding not available to most ordinary citizens, what can be done to change the social relations of expertise to counteract existing biases?

Fairer representation of more diverse interests in development and deployment of expert knowledge is the obvious tack. Primack and von Hippel advocated more, and more influential, "public interest" science. By pitting public-interest scientists against corporate and government scientists, they sought to expose uncertainties and assumptions buried in conventional expert assessments of technoscientific developments (Primack and von Hippel 1974). In effect, they were calling for a form of peer review, and in order to make it possible there needed to be more peers working in job roles that would create a different outlook from that held by insiders to business and government. While conflicts among experts may be troubling to politicians and others looking for one right answer, the diversity of opinion can be quite useful at bringing out the values normally hidden behind and within factual discourse, encouraging even those holding the dominant position to reconsider (Frankena 1992).

A more recent version of public-interest expertise is manifested by scholar-consultants working on constructive technology assessment in Europe, who seek to promote social learning about technological innovations by bringing a wider range of stakeholder groups into the inquiries, debates, and decisions about emerging technologies (Schot and Rip 1996, Hisschemoller and Hoppe 1996). Actively ensuring representation typically requires arranging for a diversity of expertise:

The presence of competing paradigms is a favorable situation for learning, as long as there is open dialogue and a good balance of cooperation and competition, and of discord and consensus. It follows that an array of constituencies must be created or strengthened, asymmetries in positions and resources must be countered, balances of power controlled. (Jelsma 1995, p. 160)

Political theorist Frank Fischer echoes these themes, with a bit more partisan bite. He proposes shifting expertise from the service of government and business elites toward what he terms "participatory research." Expert knowledge can serve people's agendas better if experts aim to collaborate rather than dominate, including collaborating on choice of research questions. This approach requires inquiry relevant to the needs of the users, who Fischer (1990) envisions as politically active ordinary citizens, not members of the formal tribunals studied by Jasanoff (1990).

The existing literature does not say much about how easily knowledge professionals can alter their focus, or whether they need to prepare in order to become more useful to political participants. In some or many cases, we suspect, experts would need deliberately to retarget their research to create more usable knowledge. Toxicologists trained to study one chemical at a time, for example, are ill prepared to provide guidance to those participating in public debates about possible synergisms among chemicals, synergisms that could be contributing to rising rates of asthma and immune-system diseases.

We suspect, moreover, that such retargeting of research agendas often would be aided by having a set of would-be users in mind. "Rather than a doomed effort to serve as masterminds, giving good advice to everyone, analysts need to conceptualize their mission along more modest lines: ...to help partisans engage in reasoned persuasion with each other" (Lindblom and Woodhouse 1993, p. 130). By providing some partisans with information they will find helpful in their interactions with allies and opponents, knowledge professionals have a reasonable prospect of actually making public debate more sophisticated. As it stands, a great deal of effort is expended on development of very generalized knowledge which turns out to contribute very little to environmental problem solving. More than a few social scientists have made a good living doing climate-change research bland enough to win grant funding from governmental funding agencies, without much apparent payoff to public understanding. Had the same resources been devoted to partisan research - aimed, for example, at bolstering the case in favor of sharp restrictions on oceanfront construction given the threat from rising sea levels in a warmer world - not only would those who participate in zoning, insurance, and other policy making be in a better position than they now are, but the act of making transparent underlying values and allegiances in the process of designing research might go a long way toward demythologizing technical expertise without ruining its image or utility. The same doubts about the value of "unbiased" research probably apply to the large sums being expended on social research connected with the Human Genome Project.

If research and consulting were to be retargeted to fit better with the needs of political participants, would it be equally valid to aim to help just any group of would-be users? Echoing Primack and von Hippel as well as Fischer, Lindblom and Woodhouse argue that counteracting existing biases requires a shift in a particular direction: toward the service of interests now under-represented by knowledge professionals. Perhaps the most important contribution experts can make to addressing social problems through thoughtful partisanship is to develop and deploy knowledge that helps level the playing field among social interests (1993, pp. 104-113). Many environmental scientists, for example, have implicitly or explicitly done this in challenging agribusiness interests regarding pesticides (e.g., Pimentel 1971). Some epidemiologists likewise have done pro bono work for communities affected by cancer clusters in the northeast and in Louisiana's cancer alley (Kulldorf et al. 1997). David Dickson argues more generally that

The substance of a truly democratic strategy for science and science policy would be...to confront the growing control of private interests over all spheres of social life... (which) means changing the conditions of access to the fruits of politically funded research so that those social groups that lack the economic or political power currently required to exploit such research are placed in position to do so. (Dickson 1988, pp. 326-327)

But would such deliberate tilting be justifiable as an across-the-board strategy? Consider this reasoning: Most professional experts now earn a living working for business executives - or for government officials essentially allied with business - who sometimes or frequently wish to use expertise for tasks not designed to promote the goals of workers, consumers, or those who seek to preserve the environment. While not denying that some government scientists at EPA (Lackey 1994), NIH, and other agencies sometimes challenge business-funded expertise, it is pretty clear that the problems and perspectives of have-nots are under-represented among experts' agendas (Woodhouse and Nieuwsma 1997, Martin 1996). Hence, the concerns, ideas, and expertise of have-nots and non-elites are less often brought to bear on social problem solving, and significant angles may be neglected or underemphasized, thereby reducing the overall intelligence of political negotiation and economic action. Hazardous waste facilities have been sited in a racist pattern, for example, partly because few experts took it upon themselves explicitly to oppose such an outcome (Bullard, 1990). Whereas partisan analysis on behalf of have-nots therefore could serve to reduce the imbalance in how expertise currently is allocated among potential clientele groups (Lindblom 1990), adding yet another expert on the side of already over-represented mainstream power holders rarely will contribute to improving the intelligence of democracy.

Representative Expertise

The above principles can be extended. Just as the rising bourgeoisie thought/fought for electoral representation starting several hundred years ago, and ideas and practices of such representation gradually have been extended (though not nearly far enough or well enough, in our judgment), we suspect that those who care about fair and wise governance of the emerging global technological civilization ought to begin thinking/fighting for the application of representative ideas and procedures to the field of expertise.

Significantly better development and utilization of expertise probably requires that the cadre of experts be drawn more or less randomly from all genders, religions, ethnic backgrounds, nationalities, and all other socially potent demographic subdivisions of humanity. Contemporary educational and related arrangements obviously constitute a significant barrier to this, skewed as they are to producing disproportionate numbers of white, male Americans among those certified as experts (Derber et al. 1990, Noble 1977). Europeans, Japanese, and a handful of other nationalities keep up in some fields, of course. And there are alternative epistemologies that deserve to be included as forms of expertise along with western scientific ones, thereby improving the representativeness of the total corps of experts. But if demographic background matters (as anyone who takes cultural construction of knowledge seriously must believe), then the existing structures and processes that generate expertise are unacceptably unrepresentative of humanity.

Improved demographics is likely to be a slow process, of course, except perhaps for gender. Meanwhile there is considerable risk that western scientific forms of expertise will continue to run rampant over alternative epistemologies (Harding 1993, Adas 1989). A second approach to improved representation, therefore, would require thinking through a conceptually difficult

issue: what would be required to structure decision-making processes so that policy analysis, expert testimony, and informal processes for advising actually take reasonable account of the broad range of expert ideas bearing on each task (where the term "expert" is understood to include many knowledge bearers outside the conventional scientific establishment)? To our knowledge, no one presently has a good answer to this question. Note that it applies every bit as much to a balance among western scientific fields - such as the standard conflict between toxicology and epidemiology in environmental health - as it does to science versus other epistemological traditions (including physical/biological sciences versus the social sciences).

It is of course improbable that such thoroughgoing reconstruction of who becomes an expert and of how expertise is drawn upon could be accomplished without considerable reconstruction of present political-economic processes and structures, including sharp constraints on the privileged position of business (Lindblom and Woodhouse 1993).

Coping with Uncertainty

Instead of pursuing the chimera of eliminating uncertainties, how might expert inquiries be partially redirected to help political participants and others *cope better* with uncertainties? Several strands of thinking on the subject agree that the answer involves preparing to learn from experience. Because uncertainty is so high at the outset of complex new endeavors, errors are inevitable; expert analysis and ordinary prudence may be able to head off some fraction of the potential errors, but another fraction - sometimes the larger one - will remain. Errors do not always have to lead to catastrophic outcomes, however; whether they do depends partly on luck and on context, but it depends also on how fast those responsible learn about the errors and make appropriate adjustments.

Ensuring Flexibility

In a series of research projects examining problems arising from expert- and bureaucrat-dominated, centralized decision making in high-tech endeavors, Collingridge (1992) identified four conditions tending to prevent flexible learning from experience. The first was large, up-front capital investments that cannot be recovered if a program proves unacceptable, as when several hundred billion dollars were expended on giant nuclear power plants before utility companies and government authorities learned that the technology was neither economically advantageous nor politically acceptable.

A second form of inflexibility is introduced when technological and other policy "trials" are structured in such a way that there is a long "lead time" between initiating the endeavor and receipt of feedback capable of determining that the program is on the wrong course: the twentieth-century's experiment with synergisms among some 100,000 synthetic organic chemicals is the quintessential example (Colborn et al. 1996).

Third, inflexibility increases when endeavors are not broken down into units small and numerous enough to allow for easy experimentation and quick learning; not many

technological endeavors can be structured for experimentation as ideally as that conducted on *Drosophila*, but some endeavors seem almost deliberately structured into units too large for learning via experimentation, such as large irrigation projects, North Sea oil, and the U.S. space shuttle (Collingridge 1992). The Danish wind-turbine experience is an excellent example of small-unit R&D with little funding outperforming large-unit R&D with heavy funding (Jorgensen and Karnoe 1995).

Fourth, if a new endeavor requires high levels of infrastructure (means to the means), it will be very difficult to undo the trial even if error suggests such a course. Having oriented the U.S. built environment and transport infrastructure toward the automobile, a major shift away from personal transport vehicles was made far more difficult than if decisions had aimed at minimizing infrastructure dedicated to the automobile (Flink 1975).

Each of the four inflexibility conditions has a converse - a tactic for preserving or enhancing flexibility: minimize up-front capital investment, keep lead time short, keep unit size small, minimize infrastructure dedicated to the new endeavor. It makes sense for users of expertise to target their interactions with experts in part toward seeking guidance about how to preserve flexibility while embarking on a new or revised endeavor. Of course, certain projects cannot be done on a small scale, at least affordably; and some scholars consider it inevitable that a technological approach will become entrenched and not very flexible (Rip et al. 1995). That may be true, or it may be that so little sustained effort has gone into building in flexibility that our imaginations are imprisoned by the relatively inflexible, large-scale approach pursued in the twentieth century: scale it up rapidly and hope for the best.

Learning by Intelligent Trial and Error

In addition to flexibility, a number of other strategies for coping with uncertainties in the regulation of risky technologies have been identified. Morone and Woodhouse (1986, 1989) assembled these into an overall strategy of "intelligent trial and error," which includes:

1. Initial precautions to guard against unacceptable risks, as when early biotechnology (recombinant DNA) experiments were conducted in containment labs;
2. Crafting initial trials flexibly, so they can be revised easily and cheaply if negative feedback warrants (see Collingridge above on the components of flexibility);
3. Redundancy and over design, so that if one approach fails a backup will be available - such as the defense-in-depth approach to design of western nuclear reactors;
4. Deliberately accelerating feedback where feasible - as by premarket testing of proposed new chemicals;
5. Careful monitoring of policy trials, preferably by more than one group and including some of the affected interests among the monitors - as in some recent hazardous waste endeavors; and

6. Frequent revision of each endeavor on the basis of what has been learned from experience.

Effective application of these strategies requires a melding of professional expertise with ordinary knowledge and commonsense. Consider the types of uncertainties faced in bioremediation of a site impacted by hazardous wastes: health risks posed by the situation, how much money or personnel will end up being required, how long the endeavor will take, the type and magnitude of undesirable side effects (traffic, spread of polluted materials), how effective the proposed remediation or protection techniques will prove, and "how clean is clean enough?" The standard approach is to guess as well as possible about these and other uncertainties, negotiating among relevant scientists, interest groups, and government officials, and then plunge ahead hoping for the best. An alternative is to admit squarely the fact that participants are uncertain and/or disagree about many important aspects of a project, and prepare to proceed via the six component strategies of intelligent trial and error discussed above.

A wide range of expertise may be helpful in this. In crafting initial precautions, for example, there is no substitute for the expertise of environmental scientists and engineers who can help envision what might go wrong (and how to reduce the damage if it does). For each project they need to ask, in effect, What is the equivalent here of the special containment labs used in early biotechnology research? Or, How can a proposed endeavor be broken into smaller units, so that errors in one part do not affect the entirety? Contemporary landfills, for example, may be divided into cells, so that if one cell leaks it does not ruin the entire endeavor.

Ecological risk assessors and political participants ought to ask how a proposed endeavor could be pursued more flexibly, building in more room for making changes on the basis of experience. How, for example, can up-front expenditures be reduced (since they are likely to be irrecoverable if the policy needs to be altered)? How can policy trials be initiated on a small-scale basis with careful monitoring, so learning can occur before large sums are expended on unproven methods?

Having built flexibility into an endeavor and thereby made alterations in policy feasible, how can monitoring and feedback about the policy be structured to be inexpensive, reliable, and quick? If the site proves less or more contaminated than originally believed, do the contractors doing the remediation have contractual incentives for reporting immediately? What sort of backup plans can be built in? Have resources been reserved for special public meetings, extra funding, or other modifications?

The particular details obviously vary tremendously from one expert-mediated endeavor to another. But invariant is the fact that all political participants - elected officials, government functionaries, lobbyists, and citizens alike - need help thinking through questions such as those discussed above if they are to effectively negotiate strategies for coping with high uncertainty. Environmental scientists and other risk experts can supply such help, without having to achieve the omniscience expected in some depictions of risk assessment, cost-benefit analysis, and other forms of knowledge deployed by experts (Woodhouse 1995).

CONCLUSION

Democratic expertise - expertise turned toward the service of democratic problem solving - has at least two central foci:

1. Counteracting bias by moving from phoney neutrality to thoughtful partisanship, working disproportionately to assist have-nots in understanding and making their case; and
2. Assisting all partisans in coping with uncertainties.

There surely are tasks for experts other than helping counteract bias and helping partisans cope with uncertainties: inventing valves, dreaming up formulas, running toxicological screens. All of these activities are value imbued, and can go astray in many ways. But they do not normally bring into sharp focus the characteristics of expertise in the service of democratic problem solving that we have emphasized in this paper: bias and uncertainty. These other activities of experts are not lesser activities, and there obviously is no sharp, magical dividing line between expert qua expert and expert as participant in democratic problem solving. But for understanding the latter role, one must understand the activities associated with bias and uncertainty. For the key *democratic* contributions of expertise are to help political participants counteract bias and cope with uncertainty, leading disagreeing partisans to think more knowledgeably and negotiate more effectively.

Some knowledge professionals occasionally do this brilliantly in contemporary environmental negotiations, but experts not infrequently fail to provide the guidance they could in helping to structure problem solving so as to promote social learning and cope with uncertainty. Sometimes, often in collusion with economic and political elites, scientists and other experts get drawn into attempting the impossible task of providing certainty - thereby shirking the far more feasible task of helping partisans negotiate broadly acceptable measures for coping with uncertainty. This is forgivable, surely, because the mastery tradition in western culture has affected almost everyone with the hubris and delusion that reality can be fully understood and controlled. It is understandable, moreover, that those in scientific, engineering, and other technical fields which have accomplished so much over the past several centuries would mistakenly interpret their successes, and would attempt to go too far; that, too, is altogether human. But such tendencies are unfortunate, potentially remediable, and certainly are not to be endorsed by the scholars who study expertise. Instead, we have an opportunity to stand back from the fray, and thereby to see more clearly what works and what does not work when expertise is drawn into the political realm. What works, we have argued, is to assist non-experts in negotiating fairly with each other concerning how to go about coping with uncertainties.

Democratic expertise is not fully developed, diffused, and employed in contemporary political systems, of course, but environmental problem solving appears to benefit substantially even from relatively low levels of it. A more developed form of democratic expertise would be able to do a much better job of helping power holders and political participants assess and negotiate

knowledge claims, mediate conflicting values, and nudge the diversity of partisan belligerents into relatively intelligent and fair collective problem solving.

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1. For a more detailed exposition of the chapter's theoretical framework, see Charles E. Lindblom and Edward J. Woodhouse, The Policy-Making Process, third edition, Englewood Cliffs, Prentice Hall, 1993, especially chapter 11, "Making the Most of Analysis."
2. This section of the paper borrows extensively from E.J. Woodhouse and Dean Nieuwsma, "When Expert Advice Works, and When it Does Not," IEEE Technology and Society Magazine, Spring 1997, 23-29.