Woodrow Wilson International Center for Scholars

STIP 01
APRIL 2010

SCIENCE + TECHNOLOGY INNOVATION PROGRAM

by Richard Sclove, Ph.D.

REINVENTING TECHNOLOGY ASSESSMENT

A 21ST CENTURY MODEL

USING CITIZEN PARTICIPATION, COLLABORATION AND EXPERT ANALYSIS TO INFORM AND IMPROVE DECISION-MAKING ON ISSUES INVOLVING SCIENCE AND TECHNOLOGY

Contents

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Abbreviations & Acronyms

CDC	Centers for Disease Control and Prevention
CRS	Congressional Research Service
CTA	constructive technology assessment
ECAST	Expert & Citizen Assessment of Science & Technology Network
DBT	Danish Board of Technology
GAO	Government Accountability Office
NAS	National Academy of Sciences
NCTF	National Citizens' Technology Forum
NIH	National Institutes of Health
NISEnet	Nanoscale Informal Science Education Network
NRC	National Research Council
OSTP	White House Office of Science and Technology Policy
OTA	Office of Technology Assessment
pTA	participatory technology assessment
PTA	Parliamentary Technology Assessment
R&D	research and development
S&T	science and technology
STIP	Science and Technology Innovation Program
STS	science, technology and society
TA	technology assessment
WWViews	World Wide Views on Global Warming

About the Author

Richard Sclove is Founder and Senior Fellow of The Loka Institute, a non-profit organization dedicated to making research, science and technology responsive to democratically decided priorities. He has been a U.S. pioneer in participatory technology assessment (pTA), having initiated the first U.S. adaptations of a Danish-style consensus conference (1997) and of a European scenario workshop (2002) – both funded in part by the National Science Foundation. He served recently as U.S. Advisor to the global secretariat of the World Wide Views on Global Warming project, the first globe-encompassing pTA exercise in world history. He has briefed U.S. and other national decision-makers on science and technology policy, and prepared testimony for the House Science Committee of the U.S. Congress.

The American Political Science Association honored Sclove's book, *Democracy and Technology*, with the Don K. Price Award as "the year's best book on science, technology and politics." Sclove is also the senior author of The Loka Institute's influential 1998 report on *Community-Based Research in the United States.* Dr. Sclove lectures widely around the world, and has published extensively in both scholarly and popular venues, including *The Washington Post, The New York Times, Science* magazine, *The Huffington Post, The Christian Science Monitor, The Chronicle of Higher Education, Technology Review* and *Science, Technology & Human Values.* He is a Fellow of the American Association for the Advancement of Science, and he has held the Ciriacy-Wantrup Postdoctoral Fellowship in Economics at the University of California at Berkeley and the Copeland Fellowship at Amherst College. Sclove earned a B.A. in environmental studies from Hampshire College and graduate degrees in nuclear engineering (M.S.) and political science (Ph.D.) from the Massachusetts Institute of Technology.

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Preface

Five years ago, our program at the Wilson Center began the first of dozens of focus groups and national surveys to better understand public perceptions, aspirations and concerns around emerging areas of science such as nanotechnology and synthetic biology. Again and again, we found that informed groups of citizens could identify a wide and rich range of issues associated with new technologies, often adding nuances to the views of experts and the policy-making community.

Over time, taking the public's pulse became integrated into our work on understanding the risks and benefits of new technologies and convinced us that public policy can be improved through sustained and carefully crafted dialogue with laypeople. But it also became obvious that interaction with the public was neither an accepted practice nor a desired outcome in most areas of science and technology (S&T) policy. The idea of "engaging the public" has had high rhetorical value in the S&T community, but little practical impact on decision-making. This paper attempts to close the gap between rhetoric and practice by providing:

- An overview of participatory technology assessment (pTA), which is specifically designed to engage a representative group of laypeople in the processes of science and technology decision-making.
- A review of recent pTA applications, drawing on both European and U.S. experiences.
- A proposal to create an institutional network that can integrate public engagement into future technology assessment activities.

The report assumes, rightly so, that technology assessment in the 21st century will not look like technology assessment in the 20th century. The rise of a highly networked global-knowledge economy is changing the interface between scientists, between the public and private sectors and between the public sector and the public it serves. In addition, the nature of science, and its potential disruptive impact, is rapidly changing. The ability to create novel biological organisms, manipulate matter at an atomic scale or intervene significantly (and possibly irreversibly) in the earth's climate system raises a host of ethical, social, legal and environmental questions that will require broad public discourse and debate. Scientific and technological innovation now requires accompanying innovations in governance mechanisms that place an emphasis on public engagement. This report envisions bringing the practice of technology assessment into alignment with the realities of 21st-century technology – to create a 21st-century model.

David Rejeski
Washington, DC
April 2010

Executive Summary

Around the world, the pace, complexity and social significance of technological changes are increasing. Striking developments in such areas as computer and communications technology, biotechnology and nanotechnology are finding applications and producing repercussions in all spheres of business, government, society and the environment.

The far-reaching social ramifications are, however, often not understood until after new technologies become entrenched. Historically this has resulted in important lost opportunities, significant social and environmental costs and channeling societal development down long-term unhealthy paths.

Technology assessment (TA) is a practice intended to enhance societal understanding of the broad implications of science and technology. This creates the possibility of preparing for – or constructively influencing – developments to ensure better outcomes. From 1972 to 1995 the United States led the world in institutionalizing the practice of TA. Then in 1995 the U.S. Congress reversed course, closing its 23-year-old Office of Technology Assessment (OTA).

Meanwhile, there are now a dozen parliamentary TA agencies in Europe. They have developed many promising TA practices, including highly effective methods involving participation by everyday citizens.* Participatory technology assessment (pTA) enables laypeople, who are otherwise minimally represented in the politics of science and technology, to develop and express informed judgments concerning complex topics. In the process, pTA deepens the social and ethical analysis of technology, complementing the expert-analytic and stakeholder-advised approaches to TA used by the former OTA. European pTA methods have been adapted, tested and proven in the U.S. at least 16 times by university-based groups and independent non-profit organizations.

There are compelling reasons to re-establish a national TA capability, incorporating both expert and participatory methods. The Internet and Web 2.0 capabilities can help a new TA institution be more effective and cost-efficient than was previously possible. Creating a modernized TA capability would also align with Obama administration initiatives to make government more transparent, accessible and responsive to popular concerns.

Lessons from the Former Office of Technology Assessment

In seeking a 21st-century TA model, it is important to learn from the OTA's experience. OTA reports were analytically rigorous and supplied extensive, in-depth and useful information. They provided Congress and the nation good value for the money. The OTA also had an oversight and pre-publication review process that ensured that studies were non-partisan. But OTA's approach also had limitations that, if understood, can lead to improvements in the TA process and ultimately to better decision-making:

- **Slow Delivery:** Some members of Congress complained that OTA reports were delivered too slowly to serve the pace of legislative decision-making.

*This report uses the word "citizen" broadly and inclusively to indicate laypeople rather than experts or representatives of organized stakeholder groups or, in a few instances, to designate people generally.

- **Misleading Presentation of Objectivity:** The OTA sometimes contributed to the misleading impression that public policy analysis can be objective, obscuring the value judgments that go into framing and conducting any TA study.
- **Uneven Treatment of Social Consequences:** OTA reports were not consistently successful in elucidating technologies' ethical and social implications.
- **Limited Insight into Synergisms and Sociotechnological Dynamics:** The OTA generally overlooked the reality that the most important social repercussions can arise from interactions among complexes of seemingly unrelated technologies. The agency likewise made little effort to understand circumstances in which a technology can induce a cascade of follow-on socio-technological developments.
- **No Citizen Perspective:** The OTA never developed a capacity to cultivate, integrate or communicate the informed views of laypeople.

Technology Assessment for the U.S. Congress: Recent Political History

OTA supporters have made numerous attempts to revive the agency. To date, none has succeeded. TA proponents have also advocated alternatives, such as strengthening the capacity of the Government Accountability Office (GAO) or the National Research Council to conduct expert TA in response to congressional requests.

Congressional response so far remains cautious. Beginning in 2002, Congress directed the GAO to conduct several pilot expert TA studies. Most recently, in November 2008 Congress asked the GAO to establish a permanent TA function. Implementation is moving slowly, with GAO contemplating initial production of one or two TA studies annually. That would be less than one-tenth of the former OTA's production rate.

A notable feature of the many efforts to restore the OTA or to create an alternative national TA capability is that proponents have generally taken little note of limitations in the OTA approach or of promising recent innovations in TA concepts and methods. OTA-style expert analysis has a vital contribution to make, but it requires improvement and supplementation to adequately address the nation's needs.

Virtues of Participatory Technology Assessment

Participation by laypeople is essential to redressing a number of the areas in which the former OTA's approach was deficient. Among the reasons to include citizen participation within the repertoire of TA methods:

- **A Matter of Democratic Right:** Lay citizens are ethically entitled to direct participation or effective representation in technological decisions as a matter of democratic right.
- **Social Values:** Experience with pTA shows that laypeople tend to excel in articulating ethical concerns and moral and social values, making and explaining value judgments and developing normatively informed insights and analysis.

- **Broader Knowledge Base:** pTA gathers and integrates life experiences and other social knowledge that expert analysis omits or undervalues.
- **Cost Reduction:** By producing an informed citizen perspective on not-yet-realized technological potentials, pTA can inform government, business and other stakeholder decision-making, thereby helping avoid or reduce costly social controversy.
- **Expedited Conclusions:** Participatory methods typically take 2 to 12 months to orchestrate and complete. This can be much more useful to policy-makers than the two years typical of the former OTA's reports.

While helpful in essential ways, pTA is not a panacea for all that is lacking in TA methods and performance. Hence there is a need for further innovation in both expert and participatory TA concepts and methods.

Expert TA and pTA are, moreover, strongly complementary: Expert TA plays a vital role in informing pTA processes. Participatory TA can likewise provide normative, analytic, empirical and other insights, and identify gaps in social understanding that can guide, inform and enrich follow-on expert TA analysis.

Criteria for a New U.S. Technology Assessment Capacity

A new national TA capability should, insofar as possible, fulfill the following criteria:

- **Participation and Expertise:** Incorporate effective citizen-participation methods to complement expert analysis.
- **21st-Century Structure:** Develop a partially decentralized, agile and collaborative organizational structure, seeking TA effectiveness, low cost and timeliness.
- **Continual Innovation in Concepts and Practices:** Encourage, evaluate and, as warranted, adopt new TA concepts and methods.
- **Non-Partisan Structure and Governance:** Establish the ethos and institutional structures needed to ensure that any new TA institution is strictly non-partisan. When there are strongly divergent normative perspectives on a particular topic, individual TA projects can benefit from a balanced, overtly value-pluralistic or multi-partisan approach.
- **Commitment to Transparent Process and Public Results.**

Practical Options for Establishing a 21st-Century TA Capability

Should a re-invented TA capability, combining expert and participatory approaches, be an agency of the U.S. Congress? This report compares the congressional option with an alternative model: a proposed new national expert-and-participatory TA institutional network – called the Expert & Citizen Assessment of Science & Technology (ECAST) network. ECAST would be independent of the government and comprise a complementary set of non-partisan policy research institutions, universities and science museums across the United States.

The Congressional Option: Establishing a new congressional TA agency, or establishing a substantial expert TA and pTA capability within an existing agency such as the GAO, would automatically confer public stature and a measure of influence upon the practice of TA at the national level. However, Congress is almost entirely unfamiliar with the concept and accomplishments of pTA, so success in this route would at a minimum entail a substantial educational effort. Another significant downside is that the staff of any new congressional OTA will be acutely aware of the demise of the previous OTA, and so is apt to be highly cautious and risk-averse. This could make it difficult to implement the experimentation, trial-and-error learning and innovation necessary to begin redressing weaknesses of the original OTA.

The Institutional Network Option: In contrast, an ECAST institutional network model could have the flexibility to organize technology assessments not only for Congress but also for the executive branch and for state or local governments. Unlike the OTA, which worked only and directly for Congress, an ECAST network could incorporate fostering societal discussion, as well as broad public education, into its mission. This would enable ECAST to inform business and other stakeholders' decision-making, and to enhance the quality of popular engagement with science-and-technology–intensive policy issues and, hence, of American democracy. Being constituted independently of the government, an ECAST network would be able to select and frame topics more creatively, pro-actively or participatively than could an agency such as OTA, which, while it did informally suggest topics to Congress, was largely forced to focus on the topics assigned to it. Operating outside of the direct line of fire of partisan Congressional politics, an ECAST network could also experiment more freely with new TA concepts and methods.

* * *

The congressional and institutional network models each have different strengths and drawbacks. On balance, the non-congressional option appears more promising in the short run. In fact, however, these two options are not mutually exclusive; they can potentially function sequentially or co-exist complementarily.

Whether within Congress, independent of Congress or both, the time is ripe. Juxtaposing the dynamism and sweeping influence of contemporary science and technology with the new organizational forms and participatory capabilities made possible in part by the Internet, the accomplishments of European pTA over the past two decades and an executive branch that is committed to advancing citizen engagement in governance, there are compelling reasons to integrate a modern, expert-and-participatory technology assessment capability into our nation's civic life.

Introduction

One decade into the 21st century, people and governments worldwide face decisions on a daily basis involving complex scientific considerations or innovations in technology. Decisions small and large – whether they are policy-makers' votes on a climate bill, biotech corporations' considerations of potential product lines, consumers' choices of food purchases or educators' use of computers in the classroom – must incorporate a dizzying array of factors.

Technology assessment (TA) is a practice intended to enhance societal understanding of the broad implications of science and technology and, thereby, to improve decision-making. The U.S. Congress set a global institutional precedent by creating an Office of Technology Assessment (OTA) in 1972. But in 1995 the Congress shut down the 23-year-old OTA, a decision that one journalist characterized at the time as "driving into the future with the headlights off."[1] Since then, the pace of technological change has only quickened, the role of knowledge in the economy has only increased and the political role of science has only become more salient in domestic and international affairs.

The time is ripe to reinvent a United States TA capability adapted to the new circumstances, challenges and opportunities facing our nation. A new national TA institution can be more decentralized, agile, collaborative, participatory – and thus effective – than was previously conceivable. These improvements can enable the practice of TA to better support government policy-makers and the American public in grappling with the complex but all-important links between technological developments, on the one hand, and social values, concerns and hopes on the other.

1. Rationale for a New U.S. Technology Assessment Capability

The reasons for establishing a new TA capability include (a) the need to respond to new as well as long-standing challenges posed by technological changes, (b) new opportunities and capabilities in methods of governance and (c) political and institutional challenges confronting the modern Congress:

Pace of Innovation: The years since 1995 have seen a dramatic increase in the pace, complexity and social significance of technological changes. There have been striking developments in such areas as computer and communications technology, biotechnology and nanotechnology, finding applications and producing repercussions in all spheres of business, government, society and the environment. Likewise, the dynamics of Internet-empowered economic globalization are transforming the landscape in which invention and innovation occur around the world.[2]

Understanding and Anticipation: A society that is experiencing rapid scientific and technological innovation needs to understand or anticipate the broad repercussions, costs and opportunities of that innovation to the best of its ability. Knowledge of the field of stakeholders, influential actors and institutions, including their perspectives and interests, is also needed. With such understanding comes the possibility of constructively influencing or preparing for developments to ensure better outcomes.[3] This is the kind of insight and perspective that an effective TA capability can contribute.

Historically, and in the absence of TA, the alternative has often been that neither citizens, their representatives nor major societal institutions have grasped the less obvious social ramifications of science and technology, or the potential practicable alternatives, until well after innovations have become entrenched. Inasmuch as technologies' indirect or unintended results often prove enormously consequential – sometimes even more consequential than those technologies' intended purposes – this can result in important lost opportunities and enormous social costs as well as channeling societal development down a long-term unhealthy path.[4]

A few historical examples of technological systems that became entrenched in the United States, and that were at least arguably sub-optimal from a societal point of view, include:

- Dependence on a private automobile system, in contrast with the more balanced mix of automobiles, strong public transit and bicycle lanes in many western European nations.

- A U.S. industrial petrochemical agriculture system that is dependent on oil and environmentally stressful, and that produces processed foods that are now identified with contributing to overeating, obesity and diabetes.
- An energy system tilted toward producing from non-renewable resources rather than toward improving the efficiency with which energy is used and prioritizing the development of renewable energy sources.
- Adoption of light water nuclear power reactors rather than safer known alternative reactor and nuclear fuel cycle designs.[5]

Take the example of automobiles. In the United States automobiles have, as intended and anticipated, supported personal mobility and freedom, as well as the expansion of vast industries. But the proliferation of cars has also constrained us to endure daily traffic jams, air pollution, the ill effects of suburban sprawl, tens of thousands of annual road fatalities and dependence on non-renewable and insecure sources of imported oil.[6]

There were, of course, no TA institutions when the U.S. automobile and highway system was becoming established during the middle decades of the 20th century. However, the practicability of comprehending and alternatively guiding that system's development is confirmed not only by the different choices made in Europe but also by the writings and activities of contemporary social critics of technology such as Lewis Mumford (in effect, the pre-eminent American TA analyst of his day).[7]

A technology-intensive society that lacks a systematic TA capability with foresight must play catch-up, responding after-the-fact to developments – sometimes irreversibly negative developments – that it, and the wider U.S. society, could instead prepare for or pro-actively influence. We see such costly catch-up reflected in escalating U.S. health care costs that are being driven in part by a medical system that is skewed toward expensive, high-technology treatment of illness rather than simpler, more economical and effective preventive strategies. We also see it in our nation's slow and timid response to the inter-related challenges of global warming, dependence on imported oil and the largely unfulfilled opportunity to develop a green economy. As we come closer – probably within months – to creating artificial life through the techniques of synthetic biology, there have been no public discussions about the utility or morality of the research, as there were none before scientists re-created the 1918 pandemic flu virus.[8]

Moreover, it is widely understood that innovations in science and technology can affect the economy, the environment and national security. It is less well appreciated that they can also profoundly influence – often through indirect, intricate or unintended pathways – all realms of human experience, including the quality of social interactions and relationships, psychological development, ethical principles, the design and functioning of institutions, the operation of laws and even fundamental political structure (see Sections 2 and 4, below). A well-crafted TA capability can assist citizens and decision-makers in understanding these kinds of broad and deep implications of technological innovation – implications that might otherwise escape attention until well after they, too, have become entrenched.

It is both dangerous and more than a little ironic that a society that often styles itself a "technological society" and an "information society" lacks – of all things– adequate information about the meaning and broad implications of science and technology.

Cost Reduction: Technology assessment is cost-effective, generating information that decision-makers can use to save money, avoid social and environmental harms and improve societal well-being. It is not possible to calculate the precise value of these benefits; however, there is evidence that TA pays for itself many times over. For instance, the OTA was able to document a case in which just one of its studies helped the

U.S. government realize more than $500 million in cost savings. Another OTA study helped save about $85 million.[9]

In comparison, a typical OTA study cost $700,000 to $1,400,000. The OTA's annual budget from 1980 to 1995 was stable in inflation-adjusted dollars at about $31 million, which funded the production of 20 to 30 technology assessments each year.[10]

Another way to frame the potential cost savings is to note that a major technology decision often involves billions of dollars in investment. If conducting a technology assessment costs less then one-tenth of one percent of the money at stake in a decision, and increases the odds that we'll get the decision right, that is a considerable bargain.

A More Level Political Playing Field: Technology assessment can help ensure that policy-makers and citizens have access to balanced information about issues involving science and technology.* In the absence of the OTA, some members of Congress and their staffs express concern that

> on important [science and technology] issues of the day, Members must turn to outside entities for information. Generally, this means turning to industry and business, because they have the resources to fund data gathering and analysis. But this in turn means that information is more likely biased and favorable toward those who created and funded such research.[11]

In the years since the OTA was established, the relative power and sophistication of interest-group lobbying has continued to increase, for example, by launching and financing "Astroturf" (faux grassroots) advocacy organizations, hiring former representatives and senators as lobbyists and drafting legislative language that becomes the basis for enacted laws.[12]

There is also growing concern that the profit motive can sometimes dangerously distort or corrupt scientific research, including agricultural and biomedical research and medical practice.[13] There may have been a time when scientific acumen was inseparable from ethics, but it is long gone. Harvard historian Steven Shapin, in his recent history of moral reasoning in science, notes that today there are no grounds to "expect expertise in the natural order to translate into virtue in the moral order." [14] For instance, in December 2009 the *New York Times* described how drug maker Wyeth (subsequently absorbed into Pfizer) encouraged doctors to prescribe hormone drugs to menopausal women, while downplaying the significant associated health risks. Wyeth "over several decades spent tens of millions of dollars on influential physicians, professional medical societies, scientific publications, [continuing medical education] courses and celebrity ads, inundating doctors and patients with a sea of positive preventive health messages."[15]

Moreover, in the absence of forward-looking technology assessment, the proprietary nature of corporate research, development and strategic planning can put businesses several years ahead of policy-makers and citizens in access to information about impending, socially consequential innovations. Corporations and trade associations can use this inside information to lobby government or establish a technological fait accompli before other social sectors know what is afoot.[16]

Technology assessment provides counterweight to ethical lapses, psychological biases and structural political imbalances of these kinds.

New Organizational Forms: When the OTA was eliminated in 1995, few people had cell phones or household Internet connections. Dr. Roger Herdman, who was the OTA's last director, remarks that "the Internet was just beginning when OTA stopped. It's astounding to think of what a new OTA could do in terms

* This report uses the word "citizen" broadly and inclusively to designate people generally or, in other contexts, to indicate laypeople rather than experts or representatives of organized stakeholder groups.

of information, productivity, and interactivity."[17] Today, Web 2.0 and social networking applications make it possible to organize activities, such as TA, in more transparent, publicly accessible, geographically distributed, collaborative, agile, flexible and cost-effective ways.

European Advances: Inspired partly by the former OTA, a dozen European nations, plus the European Parliament, have established their own technology assessment agencies. These agencies have pioneered promising new concepts and methods in technology assessment. The role of contemporary European TA "is not just to anticipate, but to open up opportunities to consider science and technology in society from different angles and to allow for feedback at different levels."[18] European TA has particularly taken a distinctive turn in developing a variety of effective and economical practices involving citizen participation (participatory technology assessment, or pTA).** European TA agencies have, furthermore, become adept in sharing methods and results, and have learned to undertake selected TA activities on a collaborative, transnational basis.[19]

One widely emulated European pTA method is a Danish-style "consensus conference." Pioneered during the late 1980s by the Danish Board of Technology (DBT), a parliamentary TA agency, a consensus conference is intended to provide policy-makers with a window into ordinary citizens' considered opinions concerning emerging technological developments, while also stimulating broad and intelligent social debate on technological issues. A carefully planned program of reading and discussion, culminating in a public forum, ensures that participating laypeople become well informed prior to rendering judgment. Both the forum and the subsequent judgment, written up in a formal report, become a focus of national attention. Consensus conference reports are, however, only advisory; they are not intended to determine public policy. Box 1 provides further description of the consensus-conference process.

Additional European pTA methods include scenario workshops, planning cells, citizen hearings, future search conferences, development spaces and deliberative mapping, as well as others.[20] As it has become more widely practiced, pTA has become increasingly influential (see Box 2).

European pTA methods have been adapted and tried in many nations, including at least 16 times in the United States (see Appendix section B). But overall, Europeans are now far ahead of the United States in effectively institutionalizing pTA methods.

Inasmuch as the U.S. OTA was abolished in 1995, whereas TA (including pTA) has flourished since that time in Europe, we are presented with something of a natural experiment on the question of whether the practice of TA actually makes a difference – and, at least arguably, a constructive difference – in sociotechnological outcomes. The answer is yes. For instance, over the past two decades European TA, including pTA, has played a role in stimulating a number of European nations, the European Union or both to undertake strategic planning and concrete activities related to adapting to global warming; to increase political awareness and develop industry strategies for entering new markets and creating jobs in green technologies (e.g., in the energy sector); to move aggressively to advance certain areas of genetic technology (e.g., pharmaceuticals) while moving much more cautiously than the United States in other areas (e.g., genetically modified foods); and to regulate *all* manufactured chemicals on the basis of group classifications (in contrast with the U.S. chemical-by-chemical regulatory approach, which leaves many chemicals unassessed and unregulated).[21] In more general terms, a recent report from the European Commission credits European participatory TA with advancing the concept and practice of "technological

** *Participatory* technology assessment is customarily abbreviated "pTA" to distinguish it from *parliamentary* technology assessment, which is abbreviated "PTA." Parliamentary technology assessment refers to any TA – participatory or not – that is conducted on behalf of a national legislative body.

A demographically diverse and balanced group of U.S. citizens deliberates at the Boston Museum of Science as part of the World Wide Views on Global Warming (WWViews) pTA project, 26 September 2009. The 78 greater Boston-area residents assembled on the same day as 4,000 counterparts gathered at four other U.S. sites and in 37 other nations spanning six continents. For information about WWViews, see Appendix section B (iii), below. (Photo by Richard Sclove.)

citizenship" in a deliberative democracy, taking practical steps to forge a bridge between parliamentary democracy and citizen participation and even contributing to the articulation of a European cultural and political identity.[22]

An Informed Society: Especially when pTA is forward looking and anticipatory, publicly disseminated results can empower all sectors of society – ranging from the various levels of government to businesses, citizens, consumers and workers – to plan their activities more effectively and at lower cost. pTA involving stakeholders or lay citizens not only provides information about scientific and technological developments, as well as technology and policy alternatives, but may also elucidate the field of actors and institutions that have an interest in or can influence those developments.[23]

For instance, European industries that were initially resistant to pTA have subsequently come to support it as a low-stress, low-cost mechanism for gauging societal reactions to alternative research, development and innovation trajectories. Regarding his nation's experience with pTA, one European industrialist commented that "product developers have worked in a more critical environment, thus being able to forecast some of the negative reactions and improve their products in the early phase." In the early 1990s Novo Nordisk, a Danish-based multi-national biotechnology company, re-evaluated its research and development (R&D) strategies after a Danish consensus conference report deplored the design of animals suited to the rigors of existing industrial agricultural systems but endorsed the use of genetic engineering to help treat incurable diseases.[24]

More generally, the democratic process as a whole benefits through the production and distribution of information that enables citizens and organizations of all kinds to consider the social significance of emerging scientific and technological developments and, if they wish, to take steps to try to influence those developments.

BOX 1.
Danish-Style Consensus Conferences – A European Participatory TA Method[25]

To organize a consensus conference, the Danish Board of Technology (DBT) selects a topic that is of social concern, pertinent to upcoming parliamentary deliberations and complex, requiring judgment on such diverse matters as ethics, disputed scientific claims and government policy. The board has found that topics suited to the consensus-conference format should be intermediate in scope – broader than assessing the toxicity of a single chemical, for instance, but narrower than trying to formulate a comprehensive national environmental strategy. The DBT then chooses a well-balanced steering committee to oversee the organization of the conference; a typical committee might include an academic scientist, an industry researcher, a trade unionist, a representative of a public interest group and a project manager from the DBT's own staff.

Next the DBT seeks volunteer lay participants, e.g., by advertising in newspapers or sending invitations to a random sample of 2,000 people. Interested candidates must submit a one-page letter describing their backgrounds and reasons for wanting to participate. From the 100 to 200 replies that it typically receives, the DBT assembles a panel of about 15 people who roughly reflect the demographic breadth of the Danish population and who lack significant prior knowledge of, or specific interest in, the topic. Groups include homemakers, office and factory workers and garbage collectors, as well as university-educated professionals. They do not, however, comprise a random scientific sample of the Danish population; after all, each panelist is literate and motivated enough to have answered an invitation or newspaper advertisement.

At a first preparatory weekend meeting, the lay group, with the help of a skilled neutral facilitator, discusses an expert background paper commissioned by the DBT and screened by the steering committee that maps the political terrain surrounding the chosen topic. The lay group next begins formulating questions to be addressed during the public forum. On the basis of the lay panel's questions, the DBT assembles an expert panel that includes scientific and technical experts, experts in ethics or social science and knowledgeable representatives of stakeholder groups such as trade unions, industry and environmental organizations.

During a second preparatory weekend, the lay group discusses more background readings and refines their questions. Afterward, the DBT finalizes selection of the expert panel and asks its members to prepare succinct oral and written responses to the lay group's questions, expressing themselves in language that laypeople will understand.

The concluding four-day public forum, held in the Danish Parliament building, brings the lay and expert panels together and draws the media, members of Parliament and interested Danish citizens. On the first day each expert speaks for 20 to 30 minutes and then addresses follow-on questions from the lay panel and, if time allows, the audience. Afterward, the lay group retires to discuss what it has heard. On the second day the lay group publicly cross-examines the expert panel in order to fill in gaps and probe further into areas of disagreement. At that time the experts are politely dismissed.

During the remainder of day two and throughout day three, the lay group prepares its report, summarizing issues on which it could reach consensus and identifying any remaining points of disagreement. The DBT provides secretarial and editing assistance, but the lay panel retains full control over the report's content. On the fourth and final day, the expert group has a brief opportunity to correct outright factual misstatements in the report, but not to comment on the document's substance. Directly afterward the lay group presents its report at a national press conference held in the Parliament building.

For additional information about Danish consensus conferences, see Appendix section A.

BOX 2.
Danish Consensus Conferences: Sample Results and Public Influence[26]

The reports prepared by the lay panel in a Danish consensus conference are typically 15 to 30 pages long, clearly reasoned and nuanced in judgment. For instance, the report from a 1992 Danish consensus conference on genetically engineered animals exhibited a perspective that was neither pro- nor anti-technology in any general sense. The panel expressed concern that patenting animals could deepen the risk of their being treated purely as objects. Members also feared that objectification of animals could be a step down a slippery slope toward objectification of people. Regarding possible ecological consequences of releasing genetically altered animals into the wild, they noted that such animals could dominate or out-compete wild species or transfer unwanted characteristics to them. On the other hand, the group saw no appreciable ecological hazard in releasing genetically engineered cows or other large domestic animals into fenced fields, and endorsed deep-freezing animal sperm cells and eggs to help preserve biodiversity.

Once the lay panelists have announced their conclusions, the Danish Board of Technology (DBT) encourages further informed public discussion by publicizing them via the Internet, local debates, leaflets and/or videos. In the case of biotechnology, for instance, during the late 1980s and early 1990s, the DBT subsidized more than 600 local debates throughout the country.

Although consensus conferences are not intended to have a direct impact on public policy, they do in some cases. For instance, conferences held in the late 1980s influenced the Danish Parliament to pass legislation limiting the use of genetic screening in hiring and insurance decisions, to exclude genetically modified animals from the government's initial biotechnology R&D program and to prohibit food irradiation for everything except dry spices.

When science and technology decisions are demonstrably responsive to the concerns of a wider range of citizens, the public is more likely to accept those decisions. For instance, after the DBT sponsored several consensus conferences and hundreds of local debates on biotechnology, a study by the European Commission in 1991 found that more Danes understood and supported their national biotechnology policies than did the citizens of other European countries. Public opinion surveys performed in 1995 revealed that, as a cumulative result of exposure to successive consensus conferences over the course of a decade, approximately 35 percent of the Danish public had become acquainted with the process. Dr. Simon Joss, who has conducted interviews on consensus conferences with Danish members of Parliament, found the legislators to be generally appreciative of the process – indeed, to the point where several members eagerly pulled down conference reports kept at hand on their office shelves.[27]

The Danish-style consensus-conference method has been adapted and used dozens of times in at least 16 other nations, including Argentina, Austria, Australia, Belgium, Canada, France, Germany, Israel, Japan, the Netherlands, New Zealand, Norway, South Korea, Switzerland, the United Kingdom and the United States.[28]

The Growing Influence of Participatory Technology Assessment: From left to right, ambassadors from Sweden, Uganda, China, Chile and India discuss the results of the World Wide Views on Global Warming pTA project in the Danish Parliament building, 19 November 2009. (Photo by Jørgen Madsen.)

The Obama Challenge: The Obama administration is seriously exploring new approaches for improving transparency, accountability and citizen engagement in governance. In its first 100 days the executive branch launched a new Office of Public Engagement, which has moved swiftly to consider broad measures applicable across the entire executive branch of the federal government.[29] This creates a political and cultural climate favorable to establishing a participatory TA capability.

At the same time, the Obama initiatives pose an institutional challenge to the Congress, which already suffers from the popular perception that it is unduly beholden to wealthy organized interests. A Congress that does not respond in kind to the Obama open-government initiatives risks looking, and increasingly becoming, out of touch with the American people. This is unhealthy for American democracy, in which the balance and separation of powers depends upon a robust and popularly responsive legislative branch.

The challenge of improving congressional responsiveness and popular support obviously transcends science and technology issues. But that wider challenge nonetheless strengthens the case for introducing not merely TA, but specifically *participatory* TA methods into congressional policy-making processes. Moreover, among the panoply of issues with which Congress must contend while re-establishing popular credibility, those involving science and technology are a promising starting point for two reasons. First, the need here is particularly great, because policy-making concerning technical issues produces such sweeping social repercussions, yet normally incorporates minimal popular engagement. Second, because the complexity of technical issues is often upheld as an insuperable barrier to citizen involvement, success in pTA can set a very strong precedent for expanding citizen engagement in all other congressional policy areas.

2. The Former Office of Technology Assessment: Its Limitations

In contemplating a new national TA capability, it is important to learn from the OTA's experience, striving to emulate what worked well, while improving or abandoning what did not.

OTA reports were analytically rigorous and supplied extensive, in-depth and useful information. They provided Congress and the nation good value for the money. Procedurally, the OTA had a strong capability to assemble pertinent teams of expert analysts, who took counsel from project advisory groups that included additional experts along with representatives of organized stakeholder groups. The OTA also had an oversight and pre-publication review process that ensured that studies were non-partisan.[30] But despite these strengths, limitations existed that, if understood, can lead to improvements in the TA process and ultimately better decision-making.

With hindsight it is evident that the former OTA displayed weaknesses that are common to other expert advisory institutions, such as the National Academy of Sciences (NAS)/National Research Council (NRC). Some of these limitations reflected the way that Congress framed the tasks that it asked the agency to perform, as well as strategic decisions that the agency made in order to function in a challenging, polarized political setting.[31] Other limitations reflected the development of a relatively stable intra-organizational worldview coupled with common bureaucratic reluctance to alter or augment established routines. Yet other weaknesses reflected the simple reality that conducting a comprehensive TA is inherently challenging and in some cases cannot be done well without fundamental improvements in TA concepts and methods.

Slow Delivery: The OTA typically took two years to produce a report, which some members of Congress and their staff complained was too slow to serve the pace of legislative decision-making.[32]

Myths of Expert Impartiality: In striving to produce studies that would be perceived as unbiased, the OTA sometimes contributed to the misleading impression that public policy analysis can be objective or value-free.[33] However, whether or not there are ever circumstances in which objectivity is attainable or even conceivable – and those are enduringly contested questions in philosophy[34] – assuredly objectivity is not achievable in the time-limited, interest-laden, hothouse atmosphere of legislative or other governmental advising.[35]

In this regard an authoritative European review of TA methods published in 2004 observes that "the

[U.S.] Office of Technology Assessment . . . represents the 'classical' TA approach. . . . The shortcomings of the classical approach can be summarized in the fact that the whole TA process . . . needs relevance decisions, evaluations, and the development of criteria, which is *at least partially normative and value loaded*. Thus, the division between value neutral scientific advice and political decision, which takes into account norms and values, cannot be kept up."[36]

At other times, the OTA operated on the assumption that a diverse group of experts who disagree among themselves can collectively achieve a certain type of impartiality, enabling them to fairly represent the range of legitimate social perspectives and judgments on a given topic. However, this assumption, too, is misleading, because the range of values, outlooks, material interests and life experiences of experts is normally different than that of the wider citizenry, often markedly so (see Box 3).[37]

In reality, OTA reports were thus less comprehensive and impartial than they purported to be, exhibiting an unnecessarily constricted range of concerns, analysis, future scenarios and policy options.[38]

Unimaginative: The preceding limitations of perspective resulted in OTA reports that could also be rather bland and unimaginative.[39] This was compounded by the OTA's propensity – again, guided by the desire to appear objective and impartial – to restrict the range of experts who were invited to contribute to TA studies and review procedures. The OTA inclined, for example, toward relying on more established, mainstream thinkers, while limiting opportunities for input from the more unconventional, iconoclastic, dissident or passionate kinds of people who are sometimes an important source of creative insight. As one former OTA project director observed in 1993, "OTA policy analysis is often too 'safe' because OTA staff are not risk takers."[40]

Uneven and Incomplete on Social Consequences: The former OTA was relatively comfortable and capable in analyzing the technical feasibility; conventional economic costs; health, safety and environmental effects; and national security implications of new technologies. In contrast, the agency could be timid and deficient in identifying and characterizing potential ethical, social, psychological, cultural, institutional and political-constitutional repercussions, even though historically these are often among the most important long-run consequences of technological change.[41]

The OTA's general inattention to role of technologies in shaping social relations and political structure – especially via indirect, subtle pathways – is of particular concern. A case can be made that establishing and perpetuating a society's basic democratic structure is a pre-eminent social value and should therefore always be included, and arguably even prioritized, in technology assessment (see Box 4).[42]

Limited Insight into Synergisms: The OTA most often studied one class of technologies at a time, overlooking the historic reality that sometimes the most important social repercussions arise from complexes of seemingly unrelated technologies.[43] For instance, in 1994 – the last full year before the OTA was subjected to the stress of impending shutdown – the agency published 41 studies and reports. Only one – a study of sustainable development in the Third World – was framed to address interactions among multiple classes of technologies in a reasonably comprehensive and integrated way.[44]

Here is an example of how social effects can emerge from the interaction among multiple technologies. Modern sofas generally have two or three separate seat cushions. Separate seat cushions define distinct personal spaces and thus respect – but also help perpetuate – modern Western culture's emphasis on individuality and privacy. However, distinct sofa cushions would not help establish cultural norms of privacy and individualism were they not part of a complex of artifacts and patterned behavior that contribute jointly toward that same result.

Other artifacts in the complex with sofa cushions include individual eating utensils (forks, spoons, knives), individual chairs, private bedrooms, personal automobiles, landline telephones that accommodate one person at a time, wristwatches, individual office desks and cubicles and, more recently, iPods and cell phones.[45]

Whether one judges the technological reproduction of the social norms of privacy and individualism as benign, deleterious, or morally complex and ambiguous is not the issue here. In the present context, it is important only to recognize that disparate technologies can conspire to produce combined social consequences that any single technology considered in isolation would not.

* * *

The OTA's weakness in addressing both social consequences and synergisms derived, at least in part, from the agency's commitment to myths of expert impartiality. Upon closer consideration, it emerges that objectivity and value-free analysis are not merely practically unattainable. The aspiration to objectivity can also be analytically limiting and therefore undesirable.[46] As Box 5 explains, *norms and values are not hindrances to sound analysis; norms of one kind or another are inescapable and necessary, and they indeed guide, inform and enrich analysis.*

Returning to the preceding sofa-spoon-chair-iPod example, it is unlikely that one would ever develop a multi-technology analysis of this kind without posing a normatively informed question, such as "Why is modern American culture so highly individualistic, and so protective of personal space and privacy, compared with many other cultures that have existed throughout history?"

There's a clue here that comprehensive TA may want to learn explicitly to adopt multiple normative perspectives to evaluate single technologies as well as complexes of multiple technologies. Conversely, one might hypothesize that TA will remain handicapped in its ability to perceive, describe and analyze sociotechnological phenomena to the extent that a commitment to (the appearance of) objectivity and impartiality blocks readiness to experiment with TA methods that are overtly normatively informed.[47]

Inattention to Sociotechnological Dynamics: The OTA in general made little effort to understand intricacies of technology-and-society dynamics. These include not-infrequent instances in which an initial technological innovation encourages (or discourages) a cascade of follow-on social and technological transformations, including the evolution of background technological, social and institutional conditions necessary to a technology's manufacture, deployment and use.[48] In some instances such dynamics can prove coercive or seductive, inducing people to take actions or produce combined results contrary to their interests or intentions.

An example would be when spillover effects from one person's adoption of a technology induce others to adopt the same technology, sometimes with collectively undesirable results. For instance, a suburban resident might decide not to purchase a power lawn mower to avoid its noise. However, after a few neighbors have bought such mowers, this person may reconsider, thinking, "Since I'm suffering from the noise anyway, why not buy my own power mower and at least benefit from the convenience?" In this way each mower contributes to a cycle that gradually transforms a tranquil neighborhood into one rent by the sound of churning engines.

A polluting or dangerous technology can also paradoxically inhibit the adoption of preferable alternatives. For instance, the danger of being hit by a car can inhibit the alternative choice to commute by a healthy, non-polluting bicycle. The safety risks associated with nuclear power stations and the pollution caused by coal-burning electric plants likewise reduce individuals' incentives to conserve energy or adopt household-level solar technology. Unless coordinated politically, such individual steps do nothing to

BOX 3.
Structural Bias among Expert Analysts

Experts, even while in conflict with one another, not infrequently share certain interests, social characteristics or latent or unconscious value orientations that differentiate them from the wider population:

1. **Shared Material Interests:** Experts – especially those most knowledgeable on any given topic – tend to share an interest in discouraging government intervention within their own areas of research (e.g., thereby "preserving the autonomy of science") while encouraging future funding for research or sharing an interest in maximizing their opportunities to benefit from research (e.g., financially or in terms of career advancement or professional standing).[49]

2. **Common Social Characteristics:** In general, experts are highly educated and socially respected, affluent, influential, networked with other persons of influence and, at least until quite recently, disproportionately white and male. A group sharing those characteristics is not necessarily well positioned to grasp or proportionally represent the range of outlooks and concerns of the enormously diverse American public.

3. **Bias with Respect to Acknowledging Social and Ethical Issues:** Committees of technical experts enjoy a privileged position in the politics of technology grounded in their distinctive command of technical knowledge. *Expert groups tend therefore to share an interest, usually quite unconscious, in downplaying the social, political, ethical or normative repercussions of technological innovation, because expanded public attention to those dimensions – in which technical experts, as such, are clearly inexpert – might erode a principal basis on which such experts have been accorded political deference and power.*[50] Supporting this point, European participatory TA methods are indeed distinguished from expert TA in the greater explicit attention typically given to power relationships, moral issues, social values and other normative considerations (see Appendix section C).

Minimization or unconscious suppression of social and ethical considerations by technical experts is evident in innumerable sociotechnological controversies in the United States and around the world over the past several decades involving the management of hazardous wastes, the acceptability of nuclear power, genetic engineering and many other issues. In such settings one can repeatedly observe affected laypeople striving to express and act on their concern, among other things, for ethical and sacred values; the transformation, disruption or destruction of community life and local traditions; the unfair consequences of unequal social power relations; or psychological stresses and harms. In contrast, committees of technical experts or government officials – who are in formal terms normally much more empowered in the controversy – often try to reduce and reframe the issues in terms of a narrow technical definition of "risk" (e.g., the probability of quantifiable harm to human biological health or to the natural environment).[51]

BOX 4.
Examples of Technologies' Indirect Consequences on Political Structure

In the late 19th century, U.S. cities experienced epidemics of typhoid fever and other communicable diseases. Over time, public health experts identified the culprit as sewage-contaminated drinking water supplies. Either local or state governments could have taken charge of the needed clean-up, but political centralization won out. State governments began appointing new public authorities to manage water and sewage on a translocal, regional scale. The result: public health improved dramatically, but local autonomy and municipal democracy suffered.

This case set a precedent emulated in other areas of infrastructural improvement: roads, ports, energy sources and telephone services. In each case, civic decisions were shifted from municipalities (where decision-making forums were often accessible to workers and everyday citizens) to larger, more remote state and national political arenas (where generally only wealthy businesses and affluent individuals possessed the resources needed to exert influence). By neglecting more local means that were available at the time for addressing urban needs, the United States underwent a fundamental change in political structure—yet without any of the political deliberation or due process that would normally be considered appropriate to social and institutional transformations of this scope, character and significance.

History did not have to unfold this way. For instance, in the case of water management, there were technological and institutional alternatives that would have made the trade-off between public health and municipal democracy unnecessary.[52]

In a more contemporary vein, there is a risk that online commerce, by draining revenue from local economies, could erode community vibrancy, public spaces and the buffering that a robust local economy affords against the vagaries of impersonal global market forces. On all three counts, this could impair conditions vital to healthy democratic self-governance.[53]

reduce a person's own exposure to the initial, technologically imposed risk or harm.[54]

Dynamics of these kinds can represent a type of market failure or collective action problem, in which individual actions combine to produce an aggregate social result that no one intended and that is socially suboptimal or undesirable. In recent years economists and other social scientists have begun developing concepts such as network externalities, path-dependent technological change and actor-network theory that may potentially be useful for analyzing such dynamics.[55]

Another type of problematic sociotechnological dynamic occurs when corporations scientifically engineer products that sustain and expand their sales market by inducing addictive consumption among users. Fast-absorbing nicotine-transfer systems in cigarettes, or processed foods loaded with high-calorie, low-chew combinations of fat, sugar and salt are two examples, both of which have significant adverse public health consequences.[56]

Institutionally Static and Insular: To its credit, the OTA never relied on a fixed conceptual framework or method for conducting its analyses; the agency understood that different problems, issues and contexts require variation in TA approach. However, over time the OTA settled upon a single, highly standardized institutional procedure for preparing studies and for assembling panels of outside advisors and reviewers of draft reports.[57] This fixed procedure inhibited the OTA from considering methodological and institutional innovations in TA methods.

The OTA, moreover, became insular in the sense that it never developed a systematic capability to monitor, encourage and, as appropriate, learn from pertinent scholarship in technology and society relationships, from extra-agency innovations in TA concepts and methods, and from experiences in TA and pTA developed outside of the United States.[58]

No Citizen Perspective: The OTA routinely incorporated the perspectives of organized stakeholder groups (e.g., academia, industry and public-interest groups). That is valuable. But the agency never developed a complementary capacity to integrate the views of ordinary laypeople. Lacking a capability in organizing participation and deliberation by representative samples of laypeople, the OTA was unable to inform Congress about *how the American people would judge and interpret* emerging scientific and technological developments.

Administrators and staff of the former OTA often contended that they were already using participatory methods, inasmuch as they regularly included representatives of organized stakeholder groups as advisors in their report preparation-and-review processes.[59] An authoritative study by some of the leading inventors and organizers of European pTA offers this clarification:

> [We] distinguish between three types of TA: classical TA, expert/stakeholder pTA, and public pTA . . . . In classical TA only the TA researcher or expert is involved . . . . The former U.S. Office of Technology Assessment (OTA) stretched this concept of classical TA by involving stakeholders in the advisory panel and the extensive external review process. . . .
>
> Whereas OTA involved stakeholders in guiding the technology assessment and reviewing the result, stakeholders were still outsiders. When the experts and stakeholders become actively involved within the TA process, we speak of expert/stakeholder pTA. Finally, we speak of public pTA when citizens play a central role in the method.[60]

The design of more recent innovations in pTA, such as Danish-style consensus conferences, thus reflects the insight that even when organized stakeholder groups are strongly represented in a TA process, this remains only a helpful step toward robust citizen, layperson or public participation (see Box 6).[61]

BOX 5.
Social Consequences, Synergisms and Value-Enriched TA

Contrary to its self-presentation, OTA analysis was never value-free. Technology assessment never is or can be.[62] Rather, the OTA relied on norms that were so commonly held among the community of TA analysts, and within the sphere of Washington, DC, public policy discourse, that they were not recognized as subjective (or, to be more precise, inter-subjective) values. OTA analysis routinely incorporated norms such as technical effectiveness and efficiency, convenience, labor productivity, employment, economic growth, human health and safety, environmental protection and national security. These criteria are widely upheld as norms in our society, but they nonetheless reflect value preferences, and not all of them command unqualified or universal respect. For instance, philosopher Albert Borgmann has advanced a reasoned critique of the norms of convenience and efficiency, arguing that their attainment is inseparable from a certain type of cultural impoverishment.[63] And growing numbers of scholars have advanced arguments against economic growth as a norm, especially when it is defined by gross domestic product.[64]

The OTA's deficiency was not in conducting value-informed analysis but in failing to explain that it was doing so, and in thereby arbitrarily privileging certain values over others that can at least arguably be defended as meriting attention.[65] Norms and values are not hindrances to sound analysis; norms of one kind or another are inescapable and necessary. Indeed, they guide, inform and enrich analysis.[66]

As one example of a vital but generally neglected normative concern: identifying and perpetuating basic structural conditions for democracy should at least arguably be a first-order consideration in technology assessment.[67] In contrast, the OTA normally did not make even a token effort to consider any given technology's potential bearing on the structural conditions of democracy.[68]

A more openly normative approach to TA might also be helpful – perhaps even essential – to assessing synergisms among multiple technologies. Consider two instances in which people already do this. First is the movement for barrier-free design among people with physical disabilities, who have learned to scan the entire technological order and built environment for ways that it inhibits or empowers their participation in social life. This normative concern has even been encoded legislatively, and applied widely in practice, via the Americans with Disabilities Act of 1990. The second example is the environmental movement, which has similarly learned to scan the entire technological order for combined repercussions on human health and the environment.[69]

Thus most OTA studies examined a single class of technology from one or more normative perspectives, but that range of perspectives was typically (mis)represented as value-free or impartial, while actually it was normatively informed and arbitrarily restricted. In contrast, value-based social movements have used a single normative concern as an overt perceptual and evaluative tool that empowers them to assess an entire technological landscape. In other words, a clear normative concern can render tractable the otherwise daunting task of assessing synergisms among multiple kinds of co-existing technologies.[70]

But exactly *which* norms ought a TA practice incorporate? That is a complex issue that cannot be fully addressed here. A first-cut answer might be that among the included norms should be those that plausibly reflect the common good of all or the perspectives and interests of the least advantaged members of a society.[71] When there is no consensus on how to select or specify such norms, it can be reasonable to adopt multiple, partly conflicting, normative perspectives.[72] In any case, TA should strive to be explicit about which norms it is deploying and why.

BOX 6.
Stakeholder vs. Layperson Participation

Participation by stakeholders, while useful, produces different results and insights than broad participation by laypeople does in several respects. First, the chosen representatives of stakeholder groups often demonstrate considerable technical expertise, acquired either through formal education or on-the-job training. In sociological terms, including them may represent an interesting broadening of conventional expert analysis rather than a complementary alternative to it. It is noteworthy that in a consensus conference, stakeholder representatives are invited to sit on the steering committee and the expert panel, but never on the lay panel.

More to the point, the aggregation of even a very diverse range of organized stakeholder interests and perspectives, while constructive, generally remains too narrow and incomplete to faithfully represent the overall common good, to capture the full spectrum of potential social impacts or to reflect the full range of layperson values, perspectives and concerns.[73]

Consider a quasi-hypothetical example: During the previous century a number of technologies – including window screens, private automobiles, sidewalk-free residential suburban streets and home air conditioning – contributed to the decline of face-to-face socializing and neighborliness in American residential communities.[74] Now imagine a conventional, prospective, OTA-style study of one or more of these technologies, conducted at an appropriate date in the past. Let's suppose that the study is advised by a committee including – in addition to outside technical experts – representatives from organized stakeholder groups, such as leaders from a consumer organization, a labor union, an environmental group and several business trade organizations. The consumer representative would predictably focus on the potential cost, convenience and safety of these technologies. The worker representative would likely dwell especially on wages, job security and safety in the production process. The environmentalist might call attention to air pollution and the depletion of non-renewable resources. A representative of realtors might be concerned to prevent heavy-handed zoning or other regulations governing the development of suburban housing tracts. These are all reasonable concerns that merit inclusion in a TA study. But notice that no one on such a study advisory committee would be likely to shout, "Hey! What about the fact that all of these innovations could inhibit neighbors from talking and socializing with one another?"

Absent any consideration of the possible effect of these technologies on social relations in daily life, there would presumably also be no attention to the follow-on question of how the technologically altered quality of community relations bears, in turn, on the basic ideals, structure and functioning of a democratic society.[75]

This is an example of how combining the views of even a very diverse range of organized stakeholder representatives, while helpful, can be insufficient to ensure that a TA study addresses the full range of significant social impacts and concerns.

A 2008 study from the NRC expresses a similar conclusion analytically:

> [M]any important interests that are widespread and important in the aggregate are not strongly held or advocated by any particular organized group. This is the classic problem of public goods or collective action. . . . Such interests are likely to have little voice in a process that emphasizes engaging stakeholders and organized groups.[76]

3. Technology Assessment for the U.S. Congress: Recent Political History and Context

Appreciative of the OTA's strengths and achievements, and notwithstanding its limitations, supporters have made numerous attempts, beginning not long after the OTA's demise and continuing to the present day, to revive it.[77] None has succeeded. A notably strong effort took place in 2001, when Representative Rush Holt (D–NJ), a Ph.D. physicist, secured 87 congressional co-sponsors – including a minority of Republicans – for a bill that would have refunded the OTA at $20 million per year for five years. That bill died in the House Science Committee without the benefit of a hearing.

Also during 2001, Senator John F. Kerry (D–MA) introduced legislation that would have created an OTA-like congressional Science and Technology Assessment Service. Kerry's initiative worked its way through a tortuous legislative process, becoming incorporated into the language of various other bills before being excised from a culminating House-Senate conference committee report.[78]

Congressman Holt made many subsequent efforts to revive the OTA, including an April 2009 attempt to provide financing through an amendment to the annual appropriation for congressional operations. His amendment was not included in the bill reported out of the House Appropriations Committee.[79]

In partisan political terms, this recent abortive attempt is significant – and for OTA enthusiasts disheartening – because, while closing the former OTA in 1995 was a Republican initiative, by 2009 both branches of Congress were under firm Democratic control. The lack of strong congressional interest in reinstating the OTA seems now to represent a bipartisan consensus.

Congressional opponents' most common argument against restoring the OTA or a congressional equivalent has been that there is insufficient demonstrated need. In the wake of OTA's demise, OTA opponents contend that other institutions – primarily the Congressional Research Service (CRS), the Government Accountability Office (GAO) and the National Academy of Sciences/National Research Council complex (NAS/NRC) – have been able to pick up the slack. Typical in this regard is the statement of Congressman Jack Kingston (R–GA), then chairman of the Legislative Branch Appropriations Subcommittee, speaking on the floor of the House in 2004:

> . . . some background in terms of the Office of Technology Assessment. In 1995 on a bipartisan level, we eliminated it, and the belief at that time was that there were other

> committees that we could turn to to get technology studies and technology assessment. Some of these, for example, are the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. All of them have hundreds of people who are technically educated. And then in addition to that, there are 3,273 people at the General Accounting Office and 729 at the Congressional Research Service. We have not suffered because of the loss of technology assessment . . . . [W]e actually have thousands of people out there doing studies, and we just need to make sure that this does not fall through the cracks. As a result of eliminating the Office of Technology Assessment, we have saved $274 million, which is serious money in tight budget times, and that is money that we can put into many other worthy causes. . . . [80]

Congress can indeed turn to the CRS for succinct, quick-turnaround, science and technology policy summaries and to the NAS/NRC complex for in-depth technical analyses of science and technology policy issues.[81]

On the other hand, a number of former OTA staffers, various science and technology policy-analysts and a concerned minority of members of Congress counter that existing institutions, at least in their current form, are unable to perform technology assessments of the OTA's caliber. In the judgment of Professor Jon Peha of Carnegie Mellon University, "[T]here is a fundamental gap in the information available to Congress. There is no consistent source of in-depth [technology] assessments that are balanced, complete, impartial, and produced at a time and in a format that is sensitive to the specific needs of Congress."[82]

Peha and others observe that Congress is indeed awash in information and analysis, including scientific and technical analysis, but lacks a trustworthy mechanism for evaluating, distilling and synthesizing this information.[83]

Enthusiasts of OTA-style expert TA argue, for example, that the CRS and GAO currently lack sufficient technical analytic capability to do the job. Like the OTA, the GAO and NAS/NRC have been criticized for operating too slowly to match the tempo of legislative decisions.[84] Moreover, according to Dr. Peter Blair, a division director in the NAS, while the NRC is adept in producing analyses that are technically robust, unbiased and authoritative, "the NRC process is not perfectly tuned to serve all government needs. For example, our process is less well equipped, currently, to go beyond technical analysis, to gauge the broader policy implications of alternative actions, especially those implications that may involve fundamental value judgments or tradeoffs for which it may be difficult or impossible to achieve consensus."[85]

However, repeated failed efforts to resurrect the OTA in its former, non-participatory mode, stretching back across the past 15 years, suggest that – regardless of the merits of the idea – it is politically unlikely to happen, at least for the foreseeable future. In the words of Republican Congressman Sherwood Boehlert, speaking in July 2006 as chairman of the House Science Committee:

> I must add that I am a very strong defender of OTA, and I voted against defunding it. . . . . But OTA is not likely to be coming back any time soon. . . . I also have to say, as a proponent of OTA, that the reaction to the loss of OTA has been somewhat disproportionate. If you listen to the scientific community, you might think that OTA was the only thing separating Congress from barbarianism.[86]

In 2008 The Keystone Center interviewed a bi-partisan sample of two dozen current and former members of Congress and their senior staff who have a strong interest in science and technology issues. One staff interviewee commented, "Many if not most staffers don't even remember the pre-1994 Congress and its long-standing institutions, and so how to get even a Democratic Congress to resurrect any kind of meaningful, funded [TA] institution is sadly difficult to imagine."[87]

The improbability of reviving the OTA in the short tem is enhanced by President Obama's proposal, in his January 2010 State of the Union address, to freeze all federal discretionary spending for the next three years.[88]

Bowing to the reality of congressional reluctance to restart the OTA, technology assessment proponents have explored and advocated alternatives, such as strengthening the capacity of the GAO or NRC to conduct expert TA in response to congressional requests, or establishing a new non-governmental, non-partisan institution for this purpose.[89]

Congressional response so far remains cautious. Beginning in 2002, partly through the initiative of Senator Jeff Bingaman (D–NM), Congress directed the GAO to conduct several pilot expert technology assessments, appropriating very modest funds for that purpose. In 2004 Congressman Holt offered a more ambitious amendment on the House floor that would have appropriated $30 million for the GAO to establish a Center for Science and Technology Assessment; 56 Democrats joined 196 Republicans to defeat the amendment by a vote of 252–115.[90]

The four pilot technology assessments that GAO has conducted since 2002, plus one more assessment that is under way on technologies for detecting explosives on passenger railways, have been framed relatively narrowly to evaluate technical feasibility and economic costs, without much policy analysis and with little or no attention to broader social or ethical repercussions.[91] A recently requested study on geoengineering (due to be completed in late 2010) has the potential to integrate a much broader set of social and ethical issues into the assessment process, though it remains unclear how GAO will accomplish this.

Most recently, in November 2008 Congress asked the GAO to establish "a permanent technology assessment function," with fiscal year 2008 authorization to spend up to $2.5 million to develop an operational plan for conducting TA. Implementation is moving slowly, with GAO contemplating initial production of one or two TA studies annually. That would be less than one-tenth of the former OTA's production rate.[92]

4. Reflection on Post-1995 U.S. Politics of Technology Assessment

A striking feature of the many efforts to restore the OTA or to create an alternative national TA capability is that proponents have generally taken it for granted that the former OTA established an unsurpassable gold standard for conducting TA on behalf of Congress and the nation. Some OTA enthusiasts concede that the agency could, and perhaps should, have developed an ability to prepare reports that were more responsive to legislative timetables. Several have also proposed, in the interest of agency survival, steps that would enable a new OTA to broaden its base of support within Congress.[93] However, overall there is a distinct rosiness to retrospective characterizations of the agency and, correspondingly, a curious disinterest in critical evaluation. An example from March 2009 is illustrative:

> The argument to restart OTA is overwhelming. . . . OTA's process . . . tapped the nation's expertise in the full range of technical and policy disciplines, placed that information in policy context, evaluated the significance of knowledge gaps and uncertainties, formulated and analyzed policy options, and communicated its results in ways that non-scientists could understand. This process was very much a collaborative and interdisciplinary enterprise, and it added value far beyond any number of one-on-one interactions with experts.[94]

A longtime science policy analyst and former OTA staffer, writing in *Issues in Science and Technology* in 2000, noted that "OTA . . . kept issues alive for analysis by describing the contending forces and inviting stakeholders to confront one another's claims. It explained all the proposed policy alternatives, even soliciting its advisors to disagree publicly. In short, the process was messy, open, and sufficiently democratic to distill the national interest out of the partisan, parochial, and presumptively self-serving."[95]

Complimentary claims such as these are not entirely without merit. But are they "impartial, balanced and complete" – that is, do they fulfill the same standards that proponents espouse for technology assessment itself? Does it make sense for OTA proponents to advocate shining the light of critical inquiry upon technologies and upon science and technology policies, but then demur from shining that same light upon the process and substance of what the OTA did? If critical inquiry will enable our society to make better decisions about science and technology, might it not also enable us to learn how to conduct technology assessment in more effective ways?

The nation was better off thanks to the work of the OTA, and we are worse off today without it. But valuable as they were, OTA studies were, as noted in Section 2, far from comprehensive or perfect. Assuredly there is an ongoing need for OTA-style expert TA. However, OTA-style expert analysis cannot by itself fulfill the promise and need for understanding technologies' social repercussions. The act of Congress that established the OTA in 1972 sought assessments that would "provide unbiased information concerning the physical, biological, economic, social and political effects" of technologies.[96] OTA did rather well on the physical, biological and conventional economic sides, but not so well on the social and political.

Post-1995 congressional consideration of the need for technology assessment has taken no note of recent innovations in TA concepts and methods.[97] For instance, a 2006 House Science Committee hearing on science and technology advice to Congress and a 2008 Keystone report on the same topic include not even a whispered mention of the accomplishments and promise of participatory TA methods.[98]

Telling also are indications that TA-attentive members of Congress, along with a portion of expert TA advocates, construe technology assessment as entailing primarily *technical* analysis of the scientific and technological dimensions of policy issues. In the words of Congressman and pre-eminent OTA-champion Rush Holt:

> Why [does Congress] need specialized, in-house scientific and technical assessments and advice? I can think of three compelling reasons: science and technology pervade almost all issues before us, including many that are not recognized explicitly as technology issues; the language and technologies are specialized and complex, and require translation for Members and their staff; and Members think science and technology are for scientists and technologists, thus avoiding science and technology themselves. Every Member is aware of the social, economic, moral, and political aspects of each of the issues before us. Not so with scientific and technological aspects of the issues before us. Members duck those aspects of the issues, flee them, ignore them, and, perhaps most often, march off oblivious to them.[99]

In a similar vein, the 2008 Keystone report quotes an unidentified member of Congress who noted that "the problem is that Members don't know to ask about science questions. And it's not just 'science' *it's the scientific aspects of non-scientific subjects*, e.g., voting issues and the technology aspects inherent in it." Advocating for re-opening the OTA in February 2010, a senior scientist from the Union of Concerned Scientists testified before Congress that OTA analysis was uniquely valuable, authoritative and credible because it was "technical" (the characterization as "technical" appears eight times in six pages of testimony) and free of value judgments.[100]

There is a crucial lacuna in highlighting the scientific and technical aspects of policy issues while overlooking *the ethical, political and other social dimensions* of those very same scientific and technical aspects. The social dimensions and repercussions of science and technology are typically latent or indirect, manifesting in part via subtle and intricate pathways of influence, and are therefore challenging to perceive, anticipate, describe or evaluate. These social dimensions are also profoundly influential, often emerging in retrospect as core constituents of how a society is organized or transformed, and even as among the key drivers of human history.[101] We neglect these social dimensions at our peril. And precisely because of the subtlety or indirectness of the avenues by which these social repercussions commonly manifest, without some assistance policymakers are ill equipped even to know they exist.

Stated in more concrete terms, stakeholder-advised expert TA (OTA's approach) normally focuses primarily on questions of the following kind: Is a technology at issue technically workable? What are its economic costs and benefits, and how are they distributed? What are the associated environmental, health and safety risks? Are there implications for national security?

These are, undeniably, important questions. Yet they are incomplete because they fail to grasp technologies' profound role, both individually and collectively, in altering the course of history and the texture of daily life. Consider the difference it would have made had our forebears learned to pose these questions – and then act responsibly on the answers – throughout the first century-and-a-half of industrialization. The world today would be somewhat cleaner and safer: thus, in certain significant respects, we would be better off. However, our societies would still have done nothing directly to comprehend, not to mention to guide or perhaps alter or avert, such major, technologically influenced developments as establishing the home as a place where a woman labored alone, the birth of the nuclear family, changing sexual mores, suburbanization, the development of public schools and romanticized childhood, the withering of craftsmanship, the shift from an agrarian/cyclic experience of time to a linear one, the creation of hierarchically managed national and transnational corporations or the evolution of modern political parties.[102]

In short, with attention confined strictly to questions of this kind, the momentous cultural developments associated with the Industrial Revolution would have come and gone without anyone noticing. Yet these questions, which are incapable even of distinguishing actions that perpetuate an agrarian social order from those promoting revolutionary political and cultural transformation, are the very questions now imagined adequate to guide us wisely through the coming century.[103]

In terms of national political process and substance, it is hard to overstate the magnitude and significance of this lacuna in the core capabilities of OTA-style technology assessment. Exclusive reliance on stakeholder-advised expert TA would make some sense if our primary need were merely for *technical* understanding of the scientific and technological dimensions of policy issues. But for a comprehensive and integrated understanding of the full social – including psychological, social, cultural, institutional, political, political-economic, legal and moral – significance of technologies, and of policies that have technical elements, expert TA has a contribution to make, but it requires improvement and cannot be sufficient.

In this respect, OTA studies were never one-sided – but neither were they comprehensive and balanced in treating social and ethical considerations with a depth, seriousness and perceptiveness comparable to that with which OTA addressed scientific, technical or economic considerations.

Nor is it possible in practice to sharply separate, analytically or procedurally, the social from the technical. Modern scholarship has demonstrated convincingly that the technological and social domains are inextricably interpenetrated, from the macro-social level down, as it were, to the sub-cellular and sub-atomic.[104] A practical implication is that expert and participatory TA methods may need to be deployed and articulated in ways that are actively complementary, mutually informing or checked and balanced against one another. European pTA is coming to acknowledge this by evolving TA processes that hybridize expert and participatory methods.[105]

Viewed from this perspective, the past decade-and-a-half of extensive and passionate professional discussion of the role of technology assessment in American political life emerges as conspicuously incomplete and, at least in part, misdirected. That conversation at times appears almost medieval in its preoccupation with angels-on-the-head-of-a-pin issues – such as whether a beefed-up GAO or NRC can adequately substitute for the OTA – when even the "best" case, by recreating the OTA's exact capabilities . . . but also its weaknesses, would result in compromising the basic mission of technology assessment: to provide comprehensive, balanced, non-partisan information about how technologies affect our daily life, our society and our world.

5. Virtues of Participatory Technology Assessment

In envisioning a new national TA capability, it is important to understand the strengths and accomplishments, as well as the limitations, of participatory technology assessment. The value of incorporating citizen participation into TA is multifold. Indeed, it emerges that participation by laypeople is essential, although not sufficient, to redressing many of the areas in which the former OTA's non-participatory approach was deficient.

Among the specific virtues of including citizen participation within the repertoire of TA methods:

A Matter of Democratic Right: Inasmuch as scientific and technological developments affect all citizens, and because citizens pay for these developments through their tax dollars and consumer purchases, they deserve direct participation or effective representation in decisions as a matter of democratic right.

Social Values: The choice of which questions to ask of an emerging technology, scientific research program or sociotechnological phenomenon is invariably value laden.[106] *Not constrained, as expert groups tend to be, by any risk that they will violate standards of professionalism or sacrifice political stature by expressing their values,*[107] *laypeople tend to excel in articulating ethical concerns and moral and social values, making and explaining value judgments and developing normatively informed insights and analysis.* Incorporating laypeople with a wide range of social perspectives into the TA process can therefore broaden the framing of issues, enliven and enrich the analysis with morally informed perspective (recall Box 5), make the social values incorporated into that analysis more explicit and clarify the values embedded in alternative technological trajectories, designs and policies.[108] Experience with pTA confirms this (see Appendix section C).

In pTA exercises such as consensus conferences, in which lay participants are chosen to approximate proportionally the demographic characteristics, life experiences and outlooks of the wider citizenry, their collective judgments furthermore offer decision-makers and the public as a whole an otherwise unobtainable – albeit inexact, non-authoritative and non-binding – representation of informed popular opinion and of the common good (see Appendix section D).[109]

This pTA-structured, layperson articulation of social values and specification of the common good can, among other things, inform and enrich subsequent expert TA analysis (again, recall Box 5).

Suppose, for instance, that a committee of technically expert TA analysts – reflecting their interest in appearing neutral and objective – is initially hesitant to deploy descriptive or explanatory concepts that overtly reflect subjective values. The danger in such reticence is that it may be impossible to discuss or even discern many important sociotechnological phenomena without using such concepts; hence, their analysis becomes impoverished and incomplete. Now, however, imagine that lay participants in a pTA exercise express their concern with how a given complex of technologies might affect, say, childhood psychological and moral development, their society's prevailing value structure, a minority subculture's spiritual values, gender or race relations, class structure, local community vibrancy or corporate power relative to that of workers or local communities. One can hypothesize that the same initial committee of experts, upon encountering the pTA results, might become inspired and empowered to bring their capabilities to bear in weighing and analyzing the claims advanced by the lay group. In that case, pTA would be informing, enriching and broadening expert TA.

Broader Knowledge Base: pTA gathers and integrates life experiences and other social knowledge that expert analysis omits or undervalues, thus complementing and strengthening expert TA methods (see Box 7). According to a 2008 study by the NRC:

> There are more than a few examples of local knowledge in the hands of those who would not normally be called experts (i.e., those lacking official credentials) serving as a corrective to a scientific or technical analysis that misrepresented the local context in which it was being applied. . . . Nor is the public's ability to strengthen the scientific and technical underpinnings of a decision always limited to local knowledge. . . . Thus, public engagement can be essential to "getting the science right."[110]

Improved Decision-Making: pTA – reflecting layperson perspectives along with those of experts and stakeholders – enables legislators and other decision-makers to make better, more broadly informed decisions about how to prepare for and influence emerging technological opportunities and challenges (see also Box 8).[111] By increasing actors' knowledge of one another's interests and perspectives, and even fostering new patterns of relationships among actors, pTA can also open new possibilities for reaching social accommodations, agreements, compromises and modifications in technology decisions.[112]

By producing an informed citizen perspective on not-yet-realized technological potentials, pTA can especially help avoid or reduce costly social controversy.

Expedited Conclusions: Participatory methods typically take 2 to 12 months to orchestrate and complete. This expedited analysis can be much more useful to policy-makers than the two years typical of the former OTA's reports. pTA exercises can be organized relatively quickly because they normally draw upon existing expert and stakeholder knowledge for input, rather than on time-consuming, newly commissioned expert studies and research.

Moreover, with use of the Internet the lead time to conduct pTA could diminish. For instance, web-based surveys can now access thousands of people to provide statistically valid samples of the U.S. population or stratified subsamples of particular demographic groups.

Also, pTA conclusions do not generally require extensive, time-consuming peer review prior to public dissemination. For instance, a Danish-style consensus conference offers expert and stakeholder witnesses a brief opportunity to correct outright factual misstatements in the lay panel's report just prior to the concluding press conference. Otherwise, the legitimacy of pTA conclusions is based primarily on procedural criteria such as representativeness, fairness, balanced informational input and transparency.

BOX 7.
The Berger Inquiry: An Example of Lay Knowledge Contributing to TA[113]

In the 1970s the Canadian government initiated a landmark pTA of a proposed high-pressure, chilled natural gas pipeline that energy companies wanted to erect through thousands of miles of northern wilderness. Named after Supreme Court justice Thomas R. Berger, the resulting inquiry took testimony from experts in formal, quasi-judicial settings. But Berger also initiated a series of informal, layperson-friendly "community hearings." Traveling 17,000 miles to 35 remote towns and settlements, the Berger Inquiry staff members recorded the testimony of nearly 1,000 Inuit (Eskimo) and Indian natives. The final report of the inquiry influenced the government to reject the original pipeline proposal in favor of an alternate route parallel to the existing Alaska Highway. According to an inquiry staff member:

> Input from nontechnical people played a key role in the Inquiry's deliberations over even the most highly technical and specialized scientific and engineering subjects. . . . [The final report] discusses the biological vulnerability of the Beaufort Sea based not only on the evidence of the highly trained biological experts . . . but also on the views of the Inuit hunters who spoke at the community hearings. The same is true of seabed ice scour and of oil spills, both complex technical subjects the understanding of which was nonetheless greatly enriched by testimony from people who live in the region.
>
> When discussion turned to . . . complex socioeconomic issues of social and cultural impact, [native] land claims, and local business involvement – it became apparent that the people who live their lives with the issues are in every sense the experts. . . . [At] the community hearings people spoke spontaneously and at length of their traditional and current use of the land and its resources. Their testimony was often detailed and personal, illustrated with tragic and humorous anecdotes.
>
> To the experts' discussion of problems and solutions, local residents were able to add comprehensive and vivid descriptions of the meaning of an issue in their daily lives. Their perceptions provided precisely the kind of information necessary to make an impact assessment.

Where expert testimony tended, moreover, to treat the proposed pipeline as an isolated occurrence, natives and other non-expert citizens adopted a more comprehensive and dynamic perspective, insisting on treating the pipeline as a probable trigger for subsequent industrial development.

In the case, again, of a Danish-style consensus conference, these considerations are monitored and assessed in real time by a balanced group of stakeholders and experts who are appointed to oversee the process.

This real-time and primarily procedural evaluation of pTA contrasts with the substantive expectation within expert TA that the results should be impartial, balanced or comprehensive, which demands a more time-consuming post hoc, independent scholarly review process.[114]

This point regarding the time required to undertake pTA bears elaboration:

First, TA agencies become more adept at organizing pTA quickly with practice and repetition. On the other hand, building a network of institutions capable of collaborating in orchestrating pTA simultaneously at multiple sites, as in the National Citizens' Technology Forum or the World Wide Views on Global Warming project (described in Appendix section B), can take a year or more.[115] However, once such a network is in place, it can be mobilized relatively quickly for new projects.[116]

Second, pTA normally depends upon experts and stakeholders to offer testimony for lay participants to consider. Participation is thus not only complementary to, but also partially dependent upon, expertise. pTA can function relatively expeditiously to the extent that it proceeds on the basis of expertise and expert analysis that are currently available. On the other hand, sometimes one conclusion of pTA is that a sociotechnological issue merits further expert inquiry; fulfilling such a recommendation entails additional time.

Public Education: When the process or results are well disseminated, pTA contributes to societal discussion, debate and understanding of the broad implications of science and technology. If a pTA process furthermore includes a range of lay people expressing themselves in their own words, it can stimulate other citizens to become interested and informed about the subject matter, in part because they can readily identify with the kinds of people involved in the pTA effort, their ethical sensibilities and their vernacular.

Build Constituency: The OTA was closed down partly because, in the absence of citizen participation or a concerted public outreach and education mission, it never built a broad constituency concerned to see it survive and thrive.

* * *

Participatory technology assessment methods have demonstrated their ability to redress some of the significant areas in which OTA-style expert analysis remains weak or deficient. But pTA is not a panacea for all that is lacking in technology assessment methods and performance.

In the first place, pTA can be designed and implemented in constructive as well as ineffective or even counterproductive ways (see Box 9).

Second, when it is done well, empowering laypeople within a TA process tends to broaden the ethical and social analysis of technology. It does not, however, ensure that that analysis will consider the full range of potential direct and indirect social repercussions, including sociotechnological dynamics and technologies' role in shaping basic social and political structure.[117] Likewise, with the exception of Danish-style scenario workshops,[118] pTA methods – like expert TA methods – will address synergisms among multiple kinds of technologies only if the organizers build that objective into the initial framing of a pTA exercise and provide concepts, tools or processes supporting inquiry into synergisms.

For these reasons there is a need for further innovation in both expert and participatory TA concepts and methods.[119]

Expert TA and participatory TA are, moreover, strongly complementary activities. For instance, expert TA plays an essential role in informing participatory TA processes. However, as noted above, participatory TA can likewise provide normative, analytic, empirical and other insights, and identify gaps in social understanding

BOX 8.
On Deliberation and Collaboration in Participatory Technology Assessment

The recent development of online collaborative methods for informing government decision-making raises the question whether a collaborative approach to technology assessment could conceivably replace pTA approaches that incorporate stakeholder or citizen deliberation. The short answer is that collaboration and deliberation are good at accomplishing different tasks, and so can most fruitfully be explored as complementary methods rather than as mutually exclusive alternatives.

As currently conceived, collaborative governance involves citizen, civil society or private sector engagement in designing and implementing government programs. Online collaboration typically elicits, aggregates and sifts the ideas of self-selected knowledgeable participants. This approach is used to identify efficient means toward ends or objectives that government officials decide in advance or that are taken for granted as unproblematic.[120] As such, collaborative governance represents a promising implementation of "instrumental rationality" – the selection of efficient means toward ends that are not under examination or in question.[121]

Instrumental rationality has its appropriate place in governance as in daily life. However, a central problem with relying on instrumental rationality excessively or unreflectively is that in the real world, ends and means are inextricably interwoven.[122] Choosing efficient means toward ends that are not examined can thus run the danger of short-circuiting the democratic process that is necessary for evaluating and determining desirable social outcomes.

In the context of technology assessment, it is impossible to do a creditable job without considering the ends or values that a technology aims to advance and that it, in addition, indirectly or inadvertently affects. And within a democratic sociopolitical context, there is no plausible, convincing and legitimate way to examine ends and values other than by well-structured deliberation.[123] Philosophers, ethicists and cultural critics, for instance, can sometimes contribute insightfully to that examination, but they cannot by themselves supply the balance of values and perspective of which deliberation is capable.

Deliberation comes in many forms and settings. It can, for example, include deliberation among elected representatives, representatives from organized stakeholder groups or lay citizens. Legislative deliberation is routine and valuable, but also subject to practical limitations. Especially within the context of emerging or potential sociotechnological developments, it is typical that at most a handful of members of Congress have time to become attentive or knowledgeable, so in this instance deliberation is not well informed by the range of values otherwise present in a legislative body. Moreover, legislators normally have no way of knowing what their constituents might eventually think about phenomena that have not yet occurred. Deliberation among stakeholders can also be valuable, but suffers from the limitation that it omits many social interests and perspectives and does not necessarily represent others in a balanced and fair way.[124] pTA, incorporating educative, deliberative and reflective dimensions, can be an essential complementary means for helping redress such limitations.

Especially in the case of emerging technologies, collaborative advising or decision-making by self-selected, knowledgeable participants would amount to delegating high social consequence, value-intensive decisions to groups likely to be dominated by a limited range of persons who are most intimately familiar with that technology. To wit, that would mean delegation to self-interested technological developers, producers, procurers, proponents or early adopters, who typically have an interest in *not* deeply or impartially considering that technology's potential, wider social repercussions.[125] Such groups thus represent, in democratic terms, a narrow and unacceptably circumscribed range of social values and perspectives.

In short, it would be misguided to posit deliberative and collaborative practices as mutually exclusive or in necessary competition with one another. More often, collaboration and deliberation will prove complementary and can, indeed, each incorporate aspects of the other.[126]

that can guide, inform and enrich follow-on expert TA analysis. The values and concerns articulated within a pTA process can, for instance, potentially inform subsequent expert or participatory studies of synergistic interactions among multiple technologies (recall Box 5).

Here is another example of potential complementarity. Lay participants in a 2006 Boston Consensus Conference on Biomonitoring made the original and intriguing suggestion that new surveillance programs that gather data on the industrial chemicals found in peoples' bodies could be used by companies and government researchers:

> to stimulate innovations in "green chemistry," the development of alternatives to potentially toxic and persistent chemicals. In addition, we believe that biomonitoring could be a stimulus and encouragement to start new "green companies." Education and consumer awareness, focused by biomonitoring data, could shift interest and attention to these companies, giving them a marketing feature in their competition with companies that use more toxic chemicals in their manufacturing.[127]

Academic researchers subsequently judged the lay panel recommendation that biomonitoring programs be used to stimulate new green industrial chemicals, processes and businesses to be "novel and important," and a suggestion not previously propounded by experts or in the literature on biomonitoring.[128] A creative and concise pTA-derived suggestion such as this could thus potentially become a fruitful topic for follow-on expert TA investigation.

In short, there is a societal need for both participatory and expert TA, as well as value in better understanding and improving their potential to complement one another.

BOX 9.
Designing and Evaluating pTA Projects

pTA can be designed and implemented in constructive, as well as in ineffective or even counterproductive, ways. For instance, including one or two laypeople on a study panel composed otherwise entirely of experts is generally ineffective. In such a setting, the token laypeople tend to remain silent.[129]

Similarly, some forms of large-scale, open and relatively unstructured lay participation – such as open online voting – may wind up, in effect, reproducing the results of conventional interest-group pluralism, which is already institutionalized effectively in other ways.

Researcher Joanna Goven has developed an insightful analysis of background institutional conditions helpful for ensuring that lay participants in a pTA exercise are enabled to frame, probe and articulate an issue broadly and on their own terms.[130] Measures must be taken to ensure, for example, that powerful actors and institutions are not able to impose framings that suppress analyses of unequal power relations in science and technology politics. It is likewise vital that the range of expert and stakeholder views presented to lay participants faithfully represents the richness of extant expert knowledge, opinion and creative insight.

Others have made recommendations for surmounting the challenges involved in effectively representing and empowering relatively silenced minority groups within pTA projects.[131]

In short, experimentation and evaluation are required to help identify promising and effective pTA methods.[132]

6. Criteria for a New U.S. Technology Assessment Capacity

On the basis of the preceding considerations, we can summarize that a new national TA capability is needed and that it should, insofar as possible, fulfill the following criteria:

- **Participation and Expertise:** Incorporate effective citizen-participation methods to complement expert analysis.

  It is not essential that expert TA and pTA be organized within the same institution. However, doing so can be advantageous, because capability in organizing one can contribute to the capacity to innovate and organize with respect to the other, while increasing a TA institution's flexibility to select methods best suited to the issue or situation that it is addressing. Combining expert TA and pTA in a single institution also opens the possibility of devising processes that fruitfully hybridize expert and participatory methods or that strengthen the complementarity between them.[133]

- **21st-Century Structure:** Develop a partially decentralized, agile and collaborative organizational structure, seeking TA effectiveness, low cost and timeliness.

- **Continual Innovation in Concepts and Practices:** Encourage, evaluate and, as warranted, adopt new TA concepts and methods, including by drawing on advances developed in academia and other civil society organizations, and by non-U.S. TA institutions. This should encompass, but not be limited to:

  (a) attention to participatory TA methods,
  (b) attention to ways that expert and participatory TA processes and results can be integrated more effectively into government policy-making, into wider societal deliberation and decision-making and into technological research, design, dissemination and management,[134]

  as well as improving capabilities to consider and influence:

  (c) the full spectrum of technologies' social, cultural, institutional, political-constitutional and normative/ethical dimensions,[135] including:
  (d) the social effects produced by synergistic interactions among different kinds of technologies and
  (e) sociotechnological dynamics.

Integrating expert TA and pTA processes into technological research, design and innovation – (b), above – is apt to pose different practical and conceptual challenges than will be entailed when using expert TA and pTA to help monitor and influence emergent synergisms among multiple kinds of technologies (d) or sociotechnological dynamics (e). Of these three tasks, the first entails "upstream" engagement in laboratories or other primary sites of research, invention and design, whereas the second and third tasks may also entail "downstream" engagement with technologies in their various contexts of manufacture, dissemination and use.[136]

Consequently, a TA practice that wishes to emulate and improve upon the OTA's constructive custom of analyzing a range of policy alternatives[137] may, among other tasks, have to propose and evaluate new societal mechanisms, institutions or opportunities for monitoring and influencing new technologies, emerging sociotechnological ensembles, the patterns of interaction among sociotechnological actors and institutions and sociotechnological dynamics. As a research team assembled by the Oak Ridge National Laboratory recently noted, there is a problematic asymmetry between our society's capacity to innovate technologically and our capacity to understand and govern such innovations: "[T]he social organizations and institutions that produce . . . breakthroughs [in science and technology] seem to be more innovative and flexible than those responsible for anticipating and coping with the effects.[138]

The necessary innovation in expert TA and pTA concepts and methods will require the efforts of experts, including interdisciplinary scholars of science, technology and society (STS) as well as social historians of technology, other social scientists and humanists, and participation practitioners (see also Appendix section E).[139]

- **Non-Partisan Structure and Governance:** From the former OTA, maintain the ethos and structures needed to ensure that any new TA institution is strictly non-partisan.

  On the other hand, when there are strongly divergent normative perspectives on a particular topic, individual TA projects can benefit from a balanced, overtly value-pluralistic, or multi-partisan approach. This might variously encompass unified reports incorporating and outlining a wide range of alternative normatively informed perspectives, competing TA teams or processes committed to divergent normative orientations, majority and minority reports, dissenting footnotes and appendices and so on.[140]

- **Commitment to Transparent Processes and Public Results:** For the purpose of public accountability and to optimally inform the broader functioning of American democracy, TA processes should generally be open and transparent, and the results should be made publicly available.

7. Can Existing Institutions Do the Job?

Do or can existing federal or private institutions fulfill these criteria? Probably not, although the case is not closed.

The universe of American institutions that already perform some TA functions include the CRS, the GAO and the NAS/NRC, as well as numerous executive branch agencies, universities and private and non-profit think tanks.

CRS reports are not made public in a systematic way.[141] The CRS, GAO and NAS/NRC are capable of producing rigorous, non-partisan expert analyses.[142] However, the analyses of these institutions, like those of the former OTA, have historically been informed by relatively narrow expert opinion that has not fully considered the all-important ethical, social, cultural and political-constitutional repercussions of technologies. Likewise, none of these institutions has experience with participation by laypeople or with open collaboration, and their long-established study procedures would certainly require substantial adjustment in order to accommodate pTA or open, collaborative methods.[143] It would also likely be difficult for any agency operating directly for and under the scrutiny of Congress, such as GAO or CRS, to experiment and continually innovate with concepts, methods and procedures not already well tested and proven elsewhere.

That said, several GAO and NRC staff members have indicated a personal openness to considering use of pTA methods. Whether that personal inclination could be translated into institutional acceptance is unclear, although opportunities will certainly arise in which pTA experiments could be integrated into planned assessments and evaluated.[144]

Federal agencies of the executive branch may choose to adopt pTA methods and do so to good effect.[145] But for serving the informational needs of Congress or the nation as a whole, these agencies would tend, as organizers of in-house studies, to be suspect. In our political system, the executive branch is controlled at any given time by one political party. Executive branch agencies therefore incline toward institutional structures and processes that will advance predetermined administration policy preferences rather than toward open-ended, impartial analysis.[146] Moreover, while capable analytically, most federal agencies would have trouble performing comprehensive TA (participatory or otherwise), because they approach the world through the lens of their respective substantive missions – energy, agriculture, defense, labor, transportation, etc. – which can militate against balanced, comprehensive and impartial multi-dimensional analysis.[147]

Likewise, universities and private and non-profit think tanks can sometimes undertake valuable TA activities – including developing and evaluating new TA concepts and methods. And they could certainly function collaboratively within a future TA network (see Section 9, below). But by themselves they cannot be counted on to serve Congress or the executive branch in a systematic and reliably responsive way, and they typically lack the oversight structure needed to ensure non-partisan or balanced results.[148]

8. Is Participatory Technology Assessment Detrimental, Redundant or Too Costly?

Several members of Congress have wondered whether a pTA capability would be detrimental or redundant.[149] Would it be detrimental because it would usurp congressional authority? Might it be redundant and therefore unnecessary, given that Congress already incorporates participation in its well-established public hearing process?

The simple answer is that pTA has never been structured or proposed as an alternative to legislative authority, only as a non-binding advisory mechanism. pTA does not usurp legislative power or prerogatives. For instance, European pTA informs parliamentary deliberations, vitally complementing the established committee, public hearing, expert advisory and pluralistic interest-group lobbying process.[150]

While the contention that pTA could usurp congressional power has occasionally found some political traction on Capitol Hill, it is hard to take it seriously on its merits. How can members of Congress, who typically show no qualms in speaking every day with streams of lobbyists representing wealthy, organized interest groups, realistically fear that their power would suddenly be diminished by listening to a representative group of well-informed everyday citizens?

Some members of Congress may also be reticent to endorse participatory advisory mechanisms after suffering through August 2009 "Congress on Your Corner" town halls on health care reform that degenerated into angry shout fests by self-selected citizens who had, in many cases, been mobilized to attend by partisan talk show hosts and social networking websites.[151] However, a carefully structured pTA process cannot be hijacked by organized interest groups in this way. In a pTA process such as a consensus conference, for example, participants do not self-select; instead, they are randomly chosen to reflect the demographic profile of a target population, such as a political jurisdiction or geographical region. Representatives of organized stakeholder groups may be invited to sit on a consensus conference steering committee or to prepare testimony as members of the expert panel, but they are excluded from sitting on the lay panel. The chosen lay participants are then presented with balanced information reflecting multiple points of view, and their conversation is moderated by a trained, neutral facilitator who ensures that everyone has an opportunity to speak and no one dominates. This is quite different from the politically vulnerable "Congress on Your Corner" format.[152]

pTA is likewise not remotely redundant, because other established participatory mechanisms give voice primarily to experts or to representatives of organized stakeholder groups. Typical well-structured pTA processes, in contrast, allow a representative sample of everyday people – people who are not active in the organized interest groups that are engaged on a particular issue under consideration – to become familiar with contrasting expert and stakeholder perspectives, deliberate among themselves and then articulate opinions that integrate this new knowledge with their own life experience, values, hopes and concerns. pTA, in short, in a balanced way nurtures and informs, and then expresses, a diverse range of popular opinion – the pluralistic views of the vast citizenry whose views are not well conveyed in formal congressional hearings or in the tumult of conventional interest-group politics.

pTA offers precisely the type of perspective that government decision-makers typically lack, and that they badly need in order to be able to craft decisions that take into account the informed will of the American people.

One might even postulate that pTA processes would specifically assist Congress in regaining some of the trust and respect that it has lost over the past years. A recent nationwide survey by the Center on Congress at Indiana University asked respondents to grade the performance of Congress in seven areas, and by far the most frequent grades given were D's and F's. Seventy-seven percent of those surveyed gave Congress a D or F on "controlling the influence of special interests," and 74 percent gave Congress a D or F on "holding its members to high ethical standards." A pTA function could counteract one of the important findings of the survey, namely, that half of Americans think Congress does not "listen and care about" what people like them think.[153]

Finally, some have expressed concern that pTA is too costly to be used on a frequent or continuing basis. Expert TA conducted by the former OTA cost on the order of $700,000 to $1,400,000 per project. The cost of conducting pTA exercises varies considerably depending on procedural design features. The National Citizens' Technology Forum on Nanotechnology and Human Enhancement (see Appendix section B(ii)) included 74 lay participants and cost on the order of $500,000, not including the additional expenditure required to evaluate the forum as a research project.[154]

pTA costs are particularly sensitive to the number of participants, if any, who must be flown to central locations, served meals and lodged overnight. Face-to-face consensus conferences in Europe have typically included about 15 lay participants and cost on the order of $150,000–$300,000 each. Conducting a comparable event in the United States with 24 lay participants meeting in a single location would cost on the order of $400,000–$800,000, owing to the higher transportation, lodging and media outreach costs in a geographically large nation. (For additional pTA cost information, see Box 10.)

In the future, greater reliance on the Internet could conceivably reduce the need for face-to-face meetings, in which case the per-participant cost of organizing pTA would drop.[155] Use of the Internet may also make it possible to increase the number and diversity of participants in pTA at relatively low cost.[156]

Section 1, above, summarized evidence and argument suggesting that OTA studies were cost-effective and offered ample social value in return for that expenditure. Inasmuch as the cost of organizing national-scale pTA exercises is of a similar order of magnitude, while pTA provides many social benefits that complement the benefits of expert TA studies (Section 5, above), there is good reason to believe that pTA is a smart and cost-effective social investment. The fact that the practice of pTA is continuing to expand in Europe and other countries around the world suggests that other nations agree with this assessment.

BOX 10.
Comparative Costs of Large-Scale pTA and Other Citizen-Deliberation Exercises[157]

This box shows the estimated cost of conducting large-scale (including transnational and global) pTA and other citizen-deliberation exercises. Four of the examples (WWViews, NCTF, European national consensus conferences and Meeting of Minds) are pTA projects; the others are also democratic citizen-deliberation projects, but their subject matter was not science- or technology-intensive. All of the meetings involved face-to-face deliberation, except the NCTF, which interspersed two face-to-face gatherings with a series of online "keyboard-to-keyboard" deliberations. Please note that this one-dimensional cost comparison obscures the many qualitative differences among these projects. Each of the methods shown has distinctive strengths and limitations, and the "best" method will vary depending upon the specific purpose and setting for a pTA or deliberation exercise.[158]

Scope*	Project or Method	Characteristics	Year	Estimated Total Cost (K = US$1,000)	Approximate Cost per Participant (US$)
G	WWViews on Global Warming	4,000 citizens from 38 nations on six continents deliberate at 44 sites for one day; very many languages.	2009	$3,500K	$900
T	European Citizens' Consultations	1,600 citizens from 27 European Union (EU) nations deliberate for three weekends in national meetings; 23 languages.	2009	$2,900K	$1,800
T	Tomorrow's Europe – Europewide Deliberative Poll	362 citizens from 27 EU nations deliberate in Brussels for three days; 21 languages.	2007	$2,175K	$6,000
	U.S. National Citizens' Technology Forum on Nanotechnology and Human Enhancement (NCTF)	74 U.S. citizens and residents at six sites across the United States meet for six days face-to-face and hold nine two-hour sessions by web.	2008	$500K	$6,700
T	Europolis Project – Europewide Deliberative Poll	348 citizens (other details as in Tomorrow's Europe).	2009	$3,625K	$10,400
	A typical national consensus conference in Europe	16 participants from one nation, one language, meet for seven to eight days.		$290K	$18,000
T	Meeting of Minds	126 multilingual citizens from nine European nations hold six days of national meetings and four days of pan-European meetings.	2005–06	$2,600K	$23,000

* "T" designates projects that are transnational in scope; "G" indicates WWViews' unique global scope.

9. Practical Options for Establishing a 21st-Century U.S. Technology Assessment Capability

Of the various kinds of institutional settings that have been contemplated for hosting a U.S. technology assessment capability,[159] two appear most promising with respect to incorporating participatory approaches as well as the other criteria listed in Section 6, above. These two settings are (1) within the Congress or (2) independent of Congress, in the form of a nationwide network of non-partisan organizations that have an appropriate mix of capabilities. Either approach would have pros and cons.

The Congressional Option

Establishing a new congressional TA agency, or establishing a substantial expert TA and pTA capability within an existing agency such as the GAO, would automatically confer public stature and a measure of influence upon the practice of technology assessment at the national level. Congressional approval of an appreciable expert-and-participatory TA capability would also signal congressional predisposition to weigh the results of TA studies within legislative deliberations, and would make it easier to coordinate the timing of TA studies with legislative timetables.

In formal legal terms, creating such an agency need not be a particularly daunting task. Congress has already asked the GAO to perform or commission a number of expert TA studies. Congress could choose to provide more funds for that purpose and specify that the expenditure should include pTA and collaborative projects.

Alternatively, when Congress closed the OTA, it eliminated the agency's funding but did not repeal the foundational legislation establishing the agency. Thus the original Office of Technology Assessment Act (Public Law 92-484) is still legally operative, and it is sufficiently non-specific that no amendment would be needed to launch a new OTA fulfilling the kinds of updated organizational and functional criteria outlined in Section 6.[160] Indeed, the fact that the act requires that the OTA be governed by a bipartisan, bicameral Congressional Technology Assessment Board (TAB) is advantageous. Thus one option would be for Congress to approve a financial appropriation, accompanied by language directing its expenditure toward establishing an OTA that incorporates citizen participation and other improvements.

The most obvious downside to this approach is that it may not be politically feasible, at least in the near term. It is not possible to predict with assurance congressional attitudes toward the idea of creating a participatory and collaborative TA capability. On the one hand, since 1995 Congress has repeatedly shown caution in moving forward to re-establish a TA function. On the other hand, Congress has never considered evidence and arguments in favor of a modernized OTA with a strong citizen-participation component. And in contrast with the many prior attempts to re-instate the OTA, the proposal to establish a participatory OTA would not be vulnerable to the counterargument that existing institutions, such as the CRS, GAO and NAS/NRC, are already doing the job or can readily learn to do so. Also, the natural turnover in Congress means that it now includes fewer members who participated in the decision to close the OTA and who might feel a need to defend that earlier action. And the Obama administration's open-government initiatives create a context favorable to institutionalizing pTA.

Inasmuch as Congress is almost entirely unfamiliar with the concept and accomplishments of pTA, one can at least predict that success in this route would entail a substantial educational effort. Another significant downside is that the administrators and staff of any new congressional OTA will be acutely aware of the demise of the previous OTA, and therefore may be even more cautious and risk averse than were their predecessors. This could make it difficult to implement the experimentation, trial-and-error learning and innovation necessary to begin redressing weaknesses of the original OTA. The considerable contemporary partisan polarization of Congress could also constitute a charged political atmosphere that would tend to further inhibit procedural flexibility and experimentation in a new congressional TA agency.

The Institutional Network Option

An alternative option would be to establish a new expert-and-participatory TA capability by connecting an appropriate set of independent, non-partisan and non-profit organizations into a nationwide network. The Internet and Web 2.0 social networking capacities make it possible to organize such an enterprise on a geographically distributed, agile and open basis, harnessing collaborative efficiencies and supporting broad public engagement on a national scale. The viability of orchestrating pTA via a network of institutional partners has been demonstrated in the United States via the multi-partner National Citizens' Technology Forum on Nanotechnology and Human Enhancement and the World Wide Views on Global Warming project (see Appendix section B).

Valuable partners within such a networked institutional framework would include universities, science museums, non-partisan policy research institutions and other non-partisan, non-profit organizations that have capabilities pertinent to expert TA and pTA. A geographically distributed, multi-institutional network could combine capabilities that it would be much more expensive, or even impossible, to house within a single-location institution, including a set of physical venues nationwide at which to host gatherings of citizen participants.

For example, an expert-and-participatory TA network needs the capacity to evaluate what it does and to develop and continually improve expert-and-participatory TA methods. Many U.S. universities have proven strengths in conceptual and methodological development in expert TA and pTA, conducting interdisciplinary analysis of sociotechnological systems and phenomena and evaluating TA projects. At least 11 U.S. universities have initiated or helped organize pTA projects over the past 13 years.[161]

An expert-and-participatory TA network should also be able to stimulate societal discussion and engage and inform citizens on a broad basis. In that regard, a number of leading U.S. science museums have developed impressive capabilities in citizen engagement; collaboration with schools; and broad public education concerning science, technology and society issues. In recent years some of these museums have organized public forums and other citizen-engagement activities under the auspices of the Nanoscale Informal Science Education Network (NISEnet), funded by the National Science Foundation.[162]

The Museum of Science Boston was a partner in the World Wide Views on Global Warming project. Science museums can bring to an expert-and-participatory TA network their local and regional community embeddedness, accessible architectural venues for face-to-face citizen engagement, an earned reputation as trustworthy purveyors of information on complex topics and a capacity for innovation in user-friendly pedagogical methods.

Securing a central node or headquarters for the network in Washington, DC, would facilitate coordination with national policy-making agendas, working relationships with Congress and the executive branch, and public education and network visibility on the national stage. A national headquarters could also function as a U.S. node or interface within an international network of institutions that are already involved in conducting expert TA and pTA exercises, thereby facilitating transnational collaboration and the exchange of best practices, expertise and findings.

An initial small set of institutional partners – including the Woodrow Wilson International Center for Scholars, the Boston Museum of Science, the Consortium for Science, Policy and Outcomes (CSPO) at Arizona State University, ScienceCheerleader and The Loka Institute–has begun planning a new national TA network combining expert and participatory capablities: the Expert & Citizen Assessment of Science & Technology Network (ECAST). These founding partners have ongoing relationships with many other institutions that would be suitable participants in an ECAST network, and they envision the network expanding gradually on an inclusive basis as opportunities and resources evolve. (See Box 11).

An institutional network model can have the flexibility to organize technology assessments not only for Congress but also for the executive branch (as does the NRC). Unlike the OTA, which was required to work only and directly for Congress, the ECAST network can incorporate fostering societal debate and discussion, as well as broad public education and outreach, into its mission, enhancing the quality of popular engagement with science-and-technology-intensive policy issues and, hence, of American democracy.[163] In virtue of being constituted independently of the government, an ECAST network will be able to select and frame topics more creatively, proactively or participatively than could an agency such as OTA, which – while it could and did informally suggest topics to Congress – was largely forced to focus on the topics assigned to it. (Serving multiple governmental clients, including on multi-national projects, stimulating broad public discussion as part of its mission and having the flexibility to set its own agenda has worked well for the Danish Board of Technology and its Dutch counterpart, the Rathenau Institute.)

As the number of participating institutional partners expands, the network could work with decision-makers to identify timely and relevant topics; engage experts and the public nationwide; facilitate in-depth learning and deliberative processes for many thousands of participants; and disseminate results to key public and private decision-makers, the expert community and a general public audience of millions. The intended results of this effort will be a better-informed, more critically thinking public, and access for decision-makers to otherwise unobtainable, vitally useful and trustworthy insight on timely issues involving science and technology.

An independent, networked approach to establishing a national expert-and-participatory TA capability has the distinct advantage that it can proceed without requiring congressional approval or appropriation – a principal reason that it is much more likely to make practical headway than have previous attempts to revive the OTA in its old governmental form. Operating out of the direct line of fire of partisan legislative politics, a non-congressional TA network will have more breathing room to experiment and innovate in TA concepts and methods.

The principal downside to the non-congressional option is that an independent network may have to work somewhat harder and more

BOX 11.
Institutional Capabilities within the Proposed ECAST Network

Science Museums	Universities	Non-partisan Policy Research Organizations
Direct public interface	Innovation in expert TA+pTA concepts and methods	Policy relevance
Community embeddedness	Capability in research and analysis	Interface with decision-makers
Trust as public educators	Evaluation of process, results and impacts	Broad dissemination of results
Capability and innovation in citizen-friendly pedagogy	Preparation of new researchers/practitioners	

creatively than would a congressional agency to establish itself as a valued provider of information to government policy-makers, and particularly to ensure that its projects are timely and that the results receive due consideration within policy-making processes.[164]

On the other hand, an ECAST network may have compensating strengths. Incorporating multiple institutions from across the nation into an expert-and-participatory TA network establishes an opportunity for many and diverse avenues of influence, not only directly with Congress but also with other agencies of the federal government and with state and local governments, as well indirectly via media outlets, the Internet, interaction with businesses and civil society organizations and broad public outreach. The Wilson Center's technological foresight work in areas such as nanotechnology and synthetic biology is well respected and has in recent years been sought after by leading policy-making institutions in the United States and abroad. In contrast with the OTA, the center, which is based in Washington, DC, reflects an innovative institutional capacity to respond nimbly to governmental needs for TA insight.[165] Arizona State University's Consortium for Science, Policy and Outcomes likewise maintains an office in Washington, DC, partly for the purpose of engaging with federal science and technology policy processes. The Boston Science Museum and other science museums excel in public education, which can, by informing public opinion, feed indirectly into political and policy-making processes.

For closer coordination and integration with national policy-making processes, the ECAST network would almost certainly benefit from assembling a functional analog to the bipartisan, bicameral Technology Assessment Board that governed the former OTA.[166]

* * *

The congressional and non-congressional alternatives each have different strengths and drawbacks. On balance, the non-congressional option appears more promising in the short run. In fact, however, these two options need not be mutually exclusive; they can potentially function sequentially or co-exist complementarily.

Especially as long as an independent ECAST network includes a physical presence in the greater Washington, DC, area, it can serve in part as a pilot testing-and-demonstration center for the Congress and the executive branch. Members of Congress and their staff, and personnel from federal agencies, will have a chance for the first time to observe participatory TA in action. With time, Congress might as a result choose to formally institutionalize an expert-and-participatory TA capability under its own auspices. This could signal the time to wind down the independent option, or (more likely) the ECAST network can continue to serve other government agencies—as a public educator and as an innovator, an evaluator, and a trainer in participatory TA and other TA methods.

If, on the other hand, the GAO gradually expands its capacity to conduct expert TA analysis – or if, as some have proposed, the OTA is eventually re-opened in its former non-participatory mode – ECAST can continue to function as a primary organizer of pTA projects. In short, whatever tasks a congressional TA agency is tasked to perform, ECAST will have the flexibility to adjust its own activities so as to essentially complement the work of its congressional counterpart.

Whether within Congress, independent of Congress or both, the time is ripe. Juxtaposing the dynamism and sweeping influence of contemporary science and technology with the new organizational forms and participatory capabilities made possible in part by the Internet, the accomplishments of European pTA over the past two decades and an executive branch that is committed to advancing citizen engagement in governance, there are compelling reasons to integrate a modern, expert-and-participatory technology assessment capability into our nation's civic life.[167]

Appendix

A. Additional Information about Danish Consensus Conferences

The Danish Board of Technology (DBT) has organized consensus conferences on the topics listed in Table A.

Table A. Danish Consensus Conference Topics[168]

- Gene technology in industry and agriculture (1987)
- Food irradiation (1989)
- Human genome mapping (1989)
- Air pollution (1990)
- Educational technology (1991)
- Transgenic animals (1992)
- Future of private automobiles (1993)
- Infertility (1993)
- Electronic identity cards (1994)
- Information technology in transport (1994)
- Integrated production in agriculture(1994)
- Setting limits on chemicals in food and the environment (1995)
- Gene therapy (1995)
- Future of fishing (1996)
- Consumption and the environment (1997)
- Telecommuting (1997)
- Citizens' food policy (1998)
- Genetically modified foods (1999)
- Noise and technology (2000)
- Electronic surveillance (2000)
- Testing our genes (2002)
- Assigning value to the environment (2003)
- Knowledge of the human brain (2005)
- New genetically modified crops (2005)

Since 2005 the DBT has continued to innovate in participatory technology assessment (pTA) methods, including via citizens' hearings on the future of the Danish health care system (2008)[169] and the World Wide Views on Global Warming project (2009, discussed in Appendix section B(iii), below).

The word "consensus" notwithstanding, the most significant feature of the consensus-conference method is the cultivation of informed citizen judgment on science- and technology-intensive policy topics involving complexity, uncertainty and social and ethical considerations.

As conceived by the DBT, the original idea behind using the term "consensus conference" is that on any given issue a legislature – no matter how divided and fractious – is striving to craft and enact *a* policy, not two, three or five contradictory policies (if there is no legislative decision, then the status quo becomes the default policy). Can a demographically balanced group of laypeople reach agreement on what they think that one policy should be? The answer to that question, on the basis of empirical evidence in Denmark and elsewhere, is yes. But it is important to note that the final report of a consensus conference in Denmark often identifies issues on which the lay panel is unable to reach agreement. Achieving consensus is thus neither the essential, the most important nor even the defining feature of the method.[170]

To prevent confusion on this score, emulators of the method in other nations have sometimes adopted a different name, including Citizens Panel (United States, 1997), Citizens Conference (France, 1998), PubliForum (Switzerland, 1999) or Citizen Forum (Germany, 2001). The report from a 1993 Dutch consensus conference on animal biotechnology included separate majority and minority opinions. Deciding in advance that consensus is not essential to the procedure, the Dutch organizers renamed their variant a "public debate."

B. U.S. Experience with Participatory Technology Assessment: Four Examples

Since 1997 there have been at least 16 U.S. adaptations of European pTA methods. Fourteen of these initiatives have been inspired by the consensus conference method and one by the scenario workshop method (Section iv, below); the other is an innovative transnational hybrid (Section iii, below). All 16 initiatives have shown that U.S. citizens and residents are willing and able to participate in pTA processes. With one partial exception (Section iii, below), all were organized in university settings as research-and-demonstration projects, and thus most lacked ties to government policy-making bodies. Funders have included the National Science Foundation, the National Nanotechnology Initiative and the National Institute of Environmental Health Sciences, as well as universities and private foundations. Here are four recent examples:[171]

(i) Boston Consensus Conference on Biomonitoring (2006).[172] Human biomonitoring involves measuring chemicals within human bodies. As the use of biomonitoring has expanded – including via programs established by the U.S. Centers for Disease Control and Prevention (CDC) and various state agencies – questions have arisen about the proper use of the resulting data. To address such questions, organizers of the Boston consensus conference assembled a highly diverse lay panel reflecting the city's demographics in terms of age, sex, race/ethnicity and income. The 15 lay members included, for instance, a truck driver, an attorney, a manager in a pharmaceutical company and an employee of a youth detention center. Three were parents of young children; eight were persons of color.

Lay participants in pTA often reach conclusions that fall within the possibility space defined by the range of expert and stakeholder testimony to which they have been exposed.[173] However, the laypeople in the Boston consensus conference creatively formulated at least two recommendations that had apparently not previously been articulated by experts. First, the lay panel proposed that unless individuals give their express permission, their biomonitoring results should be legally exempted from their medical records. The panel also articulated the novel hope that biomonitoring data could be used to stimulate more environmentally attuned "green" chemistry and production. In this latter instance the panelists, in effect, developed a "constructive technology assessment" (CTA) recommendation. (CTA is TA that aspires to influence technological innovation.[174])

This Boston consensus conference was not organized in close coordination with any government agency that had a pending responsibility to implement a biomonitoring program. However, the organizers subsequently made, and continue to make, efforts to disseminate the lay panel's conclusions. Those conclusions have been presented at many professional conferences and meetings, including those of the U.S. Environmental Protection Agency and the International Council of Chemical Associations, and communicated directly to pertinent state and federal agencies. California, the first state to establish a biomonitoring program, has used the Boston consensus statement within workshops that are informing program design, and a CDC staff member has referred to the consensus statement in public presentations. (For further discussion of the conclusions of the Boston consensus conference on biomonitoring, see Appendix section C(ii), below.)

(ii) National Citizens' Technology Forum (NCTF) on Nanotechnology and Human Enhancement (2008).[175] The NCTF is important as the first U.S. pTA exercise to be organized on a national scale. The NCTF examined the implications of radically enhancing individual human capabilities through the combined use of biotechnology, nanotechnology, information technology and cognitive science. In terms of process, the NCTF modified the Danish consensus conference method by incorporating some online deliberation. Using the Internet made it possible to expand the geographic diversity of the lay participants at reduced cost.

The NCTF took place in March 2008, and included 74 lay participants from six states (New Hampshire, Georgia, Wisconsin, Colorado, Arizona and California). The lay panelists were chosen to be demographically reflective of their respective regions. All participants received a 61-page background document, and then met face-to-face at their respective sites for a full weekend at the beginning of the month and for a concluding weekend at the end of the month. In between, the lay panelists participated together in 9 two-hour Internet sessions (keyboard-to-keyboard), posing questions online to a panel of experts, sharing concerns and perspectives among the sites and selecting and refining the common set of questions that would guide the culminating face-to-face session.

The lay panelists at each site wrote their own concluding statement of findings and recommendations on which they reached consensus. Afterward, the organizers prepared a report synthesizing the outcomes from the six sites. As a result of participating in the NCTF, the proportion of lay panelists anticipating that the social benefits of enhancing human capabilities would exceed the risks declined from 82 percent to 66 percent. All six sites registered significant concern about the effectiveness of government regulations for human-enhancement technologies and recommended better public information, education and deliberation about these technologies. Five of the six sites assigned higher priority to funding treatment of diseases than to enhancement research, and they also advocated stakeholder involvement in setting research agendas.

The organizers later described the process and findings of the NCTF at a congressional briefing, and there are indications that the NCTF may have influenced language mandating "deliberative public input in decision-making processes" within a 2009 U.S. Senate bill seeking to reauthorize the National Nanotechnology Initiative.[176]

(iii) World Wide Views on Global Warming (2009).[177] The World Wide Views on Global Warming (WWViews) project represents the first globe-encompassing pTA exercise – and, for that matter, simultaneous global democratic deliberation – in world history. WWViews enabled citizens from all over the world to define and communicate their positions on issues central to the United Nations Climate Change negotiations (COP15), which took place in Copenhagen in December 2009.

Coordinated by the Danish Board of Technology (DBT), WWViews was structured as a global alliance of individuals and institutions, including government agencies (five of them were European parliamentary TA agencies), non-governmental organizations and universities. On 26 September 2009 – six weeks in advance of the COP15 summit – WWViews national partners hosted daylong, face-to-face deliberations at 44 sites in 38 nations, including China, Russia, Brazil, India, Bangladesh, the United States (five sites) and key European nations, as well as a robust sample of other states from every inhabited continent (e.g., eight African nations).

Each WWViews deliberation included on average 90 laypeople (totalling roughly 4,000 participants worldwide), chosen to reflect their nation's or region's demographic diversity, who gathered to engage in a structured dialogue. Participants from across the globe received the same balanced scientific information material (translated into their respective local languages) and addressed an identical set of questions.[178] They voted on questions, and proposed and prioritized action recommendations, within several thematic areas: goals and urgency of climate change policy; greenhouse gas emissions targets for wealthy, intermediate and low-income developing nations; and financial mechanisms for addressing climate change. One key result is that 89 percent of the participants worldwide – including 87 percent of the U.S. participants – believe that developed nations should reduce their year 2020 greenhouse gas emissions 25-40 percent or more beneath 1990 levels, a goal much more ambitious than what most world leaders, including President Obama, have proposed.[179]

WWViews publicized results immediately via the World Wide Web. WWViews institutional partners and the DBT also communicated the results directly to national delegations to the COP15 summit, as well as to national politicians, stakeholder groups and the media. As the first extension of pTA practice to the global level, WWViews has proven groundbreaking in its influence. For instance, ambassadors from China, India, Sweden, Chile and Uganda participated in a panel discussion about WWViews in the Danish Parliament on 19 November. As of mid-November 2009, the project secretariat reported that WWViews results were being taken seriously on a ministerial level in Australia, Austria, Bolivia, Chile, Denmark, Finland, Norway and Sweden – and quite likely, based on WWViews National Partner dissemination plans, in many other nations. Project results were also handed directly to the President of Chile and to the Prime Minister of Saint Lucia, who was point person to COP15 for the Caribbean Community & Common Market.[180]

The United States was represented in WWViews by institutional partners based in five greater metropolitan areas: Atlanta, Boston, Denver, Los Angeles and Phoenix. Global and U.S. results were presented in a briefing to staff of the White House Office of Science and Technology Policy (OSTP) and of the Council on Environmental Quality, conveyed by OSTP to staff of the White House Office of Energy and Climate Change Policy and communicated to staff of the Senate Foreign Relations Committee and of the State Department's Special Envoy for Climate Change. With funding from the National Science Foundation, a subset of the U.S. partners in WWViews is also coordinating the international effort to evaluate the WWViews process and impact.

(iv) Lowell, Massachusetts Scenario Workshop on Urban Ecology and Democracy (2002).[181] A scenario workshop is a European pTA process in which selected stakeholder representatives and laypeople critique competing, expert-prepared future scenarios. The scenarios use engaging narratives of daily life to describe alternative social and technological means of advancing a societal objective, such as creating more ecologically sustainable urban communities. Workshop participants use the scenarios as a starting point for crafting desired visions and action plans for their own communities. Among TA methods, scenario workshops are intriguing in their ability to consider the combined direct and indirect repercussions of complexes of seemingly unrelated technologies (e.g., urban energy, transportation, food production, water, sewage and garbage systems).

Seventy city residents, including business and government representatives, technical experts and members of citizen-action groups, participated in the two-day Lowell scenario workshop. The project modified the European scenario workshop format by adding several new steps in which participants were asked to evaluate the initial expert scenarios, as well as their own visions and action plans, using a set of democratic design questions (Table B, below). To keep that task manageable, the questions were divided among participants so that each person used one, or at most two, questions. (All participants were asked to consider the concluding question, no. 19). As a contribution toward the methodology, the participants also evaluated the questions after having used them. The Lowell scenario workshop represented a pioneering attempt to ensure that multiple technologies advance their intended aim (in this instance, urban environmental sustainability), in a manner compatible with maintaining a robustly democratic civil society.

Participants presented their conclusions at a city hall press conference hosted by Lowell's mayor. The mayor and city planners expressed eagerness to incorporate the results into their planning processes.

Table B. Questions to Help Examine the Effects of Technologies upon a Community's Democratic Structure[182]

One purpose of the Lowell scenario workshop is to gauge the effects of technology upon communities through the help of the social and political questions listed below. We've illustrated the meaning of each question with a technological example. Please note that each question can apply to many different kinds of technologies, not just to the one technology that we use in each example.

Take the first question, Individualism and Commonality: Although the illustrative example mentions carpooling, many other technologies besides cars or other transportation technologies can affect how much time we spend alone versus interacting with other people. Just think of the difference in social interaction that happens when someone: (a) washes clothes at home with a washing machine; (b) goes to a laundromat; (c) takes clothes to a dry cleaning shop; (d) scrubs clothes collectively at a village washbasin; (e) leaves dirty clothes in a hamper for a paid domestic employee to wash; etc. So although the example mentions carpooling, in reality the question -- like all of the table's questions – can apply to many other kinds of technologies as well.

Table B. continued

TECHNOLOGY & SOCIAL RELATIONS

1. **Individualism and Commonality** — In some major urban areas, designated "carpool lanes" on highways have prompted on-the-spot carpooling, where commuters leave their cars to ride with complete strangers into city centers. **Would any technologies in the scenario affect how, and how often, you would interact with other people?**

2. **Forming Groups** — In the past, large factories producing automobiles, refrigerators and other durable products made it easy for workers to form groups, like unions or bowling teams. **Would any of the technologies in the scenario affect peoples' ability to form groups?**

3. **Cultural Diversity** — New cotton farming technologies, combined with expanded factory production in northern U.S. cities, brought millions of African Americans out of the South during the first half of the 20th Century. This "Great Migration" helped Rhythm & Blues music gain acceptance in mainstream culture. Some historians think this helped the civil rights movement during the 1960s. **Would any technologies in the scenario affect your exposure to different cultures?**

4. **Fairness** — People with physical disabilities have enhanced their involvement in social life by lobbying for "barrier-free" design solutions, such as wheelchair-negotiable buses, sidewalk curbs and buildings; Braille-encoded elevator buttons; public phones with adjustable volume; and so on. **Do any of the technologies in the scenario affect the economic or social opportunities of disadvantaged groups?**

5. **Influence** — Dissidents have used the Internet and text-messaging to challenge authoritarian political regimes. **Would any technologies in the scenario redistribute power and influence in society?**

TECHNOLOGY, PERSONAL GROWTH & SOCIAL LEARNING

6. **Personal Growth** — The Internet is making it possible for increasing numbers of people to access free, online instruction in a huge variety of topics, ranging from vocational and professional skills to artistic and even spiritual development. **How would the scenario's technologies affect peoples' ability to choose career paths and to develop other talents?**

7. **Burdens** — Household recycling and composting are great for the environment, but can also be time-consuming. **Are there technologies in the scenario that create burdens or constraints for people? Would some people shoulder more of these burdens than others?**

8. **Citizenship** — Many suburbanites commute to work in a different town and stay home indoors at night. They watch television and shop via catalogs or the Internet, and may feel little responsibility to their neighbors. **Would any of the technologies in the scenario increase or lessen peoples' readiness to act as responsible citizens?**

Table B. continued

9. Social Learning — The ancient Greek philosopher Socrates would have loved the Internet. It makes it possible to ask questions and learn interactively with people nearby and across the world. **Would any of the technologies in the scenario affect opportunities to learn about the world and to share ideas with other people?**

TECHNOLOGY & GOVERNANCE

10. Centralization/Decentralization — If a city decides to build an international airport, it becomes subject to regulation and oversight by the Federal Aviation Administration (FAA). That removes some decision-making power from local authorities. **Do any of the technologies in the scenario require state or federal involvement?**

11. Exporting Harm — Lowell currently sends its solid waste to be burned downwind from the city. **Would any of the technological solutions employed in the scenario create problems outside of Lowell? Could this lead to state or federal intervention?**

12. Institutional Responsiveness — Everyone knows the frustration of encountering modern business voice-mail systems that seem custom-designed to make it impossible to talk with a living person. **Would any technologies in the scenario affect the responsiveness of important institutions (such as businesses, financial institutions, and government agencies)?**

14. Civil Rights and Liberties — The civil rights movement gained moral and political force when it achieved national television exposure in the 1960s. **Would any of the technologies in the scenario affect the protection of civil rights and liberties?**

TECHNOLOGY & SOCIAL SUSTAINABILITY

15. Economic Specialization — It can be risky to rely too heavily upon a single industry to fuel economic growth. Detroit relied heavily on the automobile industry during the 1970s, and this led to problems when the industry confronted foreign competition. **Do any of the technologies in the scenario affect the diversity and robustness of the local economy?**

16. Flexibility — Some architects have designed buildings with moveable walls, so that apartments can be reconfigured as families grow and shrink. **Are the technologies in the scenario flexible, so that people would be able to change their minds about how they want to live?**

17. Vulnerability — The City of Boston transports most of its drinking water from the Quabbin Reservoir in western Massachusetts. This technology brings cheap water to millions, but may be vulnerable to terrorist sabotage. We may have to restrict civil liberties to prevent such sabotage in the future. **Are any technological solutions in the scenario vulnerable to catastrophic sabotage?**

Table B. continued
18. Democratic Security — Reliance upon gas-fueled automobiles and foreign oil imports compels the U.S. to maintain a strong military presence in the Persian Gulf. This has had complex consequences for international peace and security. **Do any of the technological decisions in the scenario affect international peace, security or democracy in other nations?**
TECHNOLOGY & UNPLANNED CONSEQUENCES
19. Suppose the scenario is fully realized? What would be the problems?

C. Ethics and Social Values in Expert vs. Participatory Technology Assessment: Two Comparative Case Studies

How do expert and participatory TA processes compare in how they address technologies' social and ethical dimensions? We can explore this question by comparing expert and participatory TA studies that have addressed the same topics at the same time.

Note that the comparative content analysis in Section C necessarily includes an element of subjective judgment and interpretation. Readers are, accordingly, invited to read the original sources and draw their own conclusions.

(i) Mapping the Human Genome: OTA Experts Compared with a Danish Consensus Conference (1988–89). This first comparison is, if anything, biased in OTA's favor inasmuch as the OTA study was prepared by one of the OTA divisions that OTA staffers consider to have been most adept in elucidating social and ethical issues.[183]

The conclusions of a pTA process, such as a consensus conference, can be penetrating and impassioned in comparison with the circumspection and dry language that is conventional in expert policy analyses. For instance, having noted that the "idea of genetic normalcy, once far-fetched, is drawing close with the development of a full genetic map," a 1988 expert OTA analysis of human genome research concluded blandly that "concepts of what is normal will always be influenced by cultural variations." In contrast, a 1989 Danish pTA consensus conference on the same subject recalled the "frightening" eugenic programs of the 1930s and worried that "the possibility of diagnosing fetuses earlier and earlier in pregnancy in order to find 'genetic defects' creates the risk of an unacceptable perception of man – a perception according to which we aspire to be perfect." The lay group went on to appeal for further popular debate on the concept of normalcy. Fearing that parents might one day seek abortions upon learning that a fetus was, say, color-blind or left-handed, 14 of the panel's 15 members also requested legislation that would make fetal screening for such conditions illegal under most circumstances.

A central concern with social issues becomes more likely when expert testimony is integrated with everyday-citizen perspectives. For instance, while the executive summary of the OTA study on human genome research states that "the core issue" is how to divide resources so that genome research is balanced against other kinds of biomedical and biological research, the Danish consensus conference report opens with a succinct statement of social concerns, ethical judgments and political recommendations. These perspectives are integrated into virtually every succeeding page, whereas the OTA study discusses "social and ethical considerations" only in a single chapter. Indeed, that chapter was the shortest in the OTA report (11 pages out of 218 pages total), and not a single concept of substance from the "ethics" chapter appears in the OTA report's 15-page executive summary – generally the only portion of an OTA report that was read by members of Congress or their staff.[184]

The Danish consensus conference report concludes with a call for more school instruction in "subjects such as biology, religion, philosophy, and social science"; better popular dissemination of "immediately understandable" information about genetics; and vigorous government efforts to promote the broadest possible popular discussion of "technological and ethical issues." The corresponding OTA study does not consider such ideas.

When the Danish lay group did address the matter of how to divide resources, members differed significantly from the OTA investigators. Rather than focusing solely on balancing different kinds of biomedical and biological research against one another, the Danish group supported basic research in genetics but also called for more research on the interplay between environmental factors and genetic inheritance, and on the social consequences of science. They challenged the quest for exotic technical fixes for disease and social problems, pointing out that many proven measures for protecting health and bettering social conditions and work environments are not being applied. Finally, they recommended a more "humanistic and interdisciplinary" national research portfolio that would stimulate a constructive exchange of ideas about research repercussions and permit "the soul to come along."

Readers may form their own opinions about the relative merits of the analyses and judgments advanced by OTA expert groups compared with those of the Danish lay panel. It seems clear, however, that the consensus conference report frames its social analysis more broadly, and that its ethical analysis – while not necessarily more compelling (a judgment that will depend on one's own values and priorities) – is more resolute and, at least arguably, more incisive.

Impressed by the performance of the lay panelists during a 1999 Danish consensus conference on genetically modified foods, a member of the expert panel later commented, "Lay people will not be constricted to narrow perspectives, for instance economic considerations . . . they will discuss [the topic] in terms of their ideas of what the good society should be like."[185]

On the other hand, while less accessibly and less engagingly written, and less attentive to social considerations, a traditional OTA report provided substantially more technical detail and analytic depth than a report from a lay group. For that reason OTA-style expert analysis has its own considerable merits and can also contribute to pTA processes. For example, a 1993 Dutch consensus conference on animal biotechnology used a prior OTA study as a starting point for its own, more participatory inquiry.

* * *

For our purposes, the preceding comparison is salient because it contrasts an OTA expert assessment with the report from a Danish consensus conference prepared during the same time period. However, is it possible that the Danish lay panel's close attention to social and ethical concerns reflects peculiarities of Danish culture that might not obtain in the United States? To test this hypothesis, we can compare two 2006 reports on human biomonitoring for environmental chemicals, one prepared by a committee of experts assembled by the U.S. National Research Council (NRC) and the other by the lay panel from a Boston consensus conference (Appendix section B(i), above).

(ii) Human Biomonitoring: NRC Experts Compared with a Boston Consensus Conference (2006). In several respects, the NRC biomonitoring study and Boston consensus conference are complementary, each addressing issues, presenting information and incorporating perspectives that the other does not.

The NRC study differs from the 1988 OTA study in acknowledging ethical issues throughout the report and executive summary. This may reflect the fact that both the NRC study committee and its external peer reviewers included experts in public health, who, among technical experts, tend to be more accustomed to addressing ethical and social-justice issues.

Both the NRC committee and Boston lay panel identified ethical issues involved with protecting the confidentiality, rights and interests of the human subjects in biomonitoring studies. However, in a number of instances the NRC committee was able to offer little insight into how to think about those issues. In those cases their report recommends further research on ethical issues, indicating that "only open discussion between scientists and ethicists can promote consensus on the issues. . . ."[186]

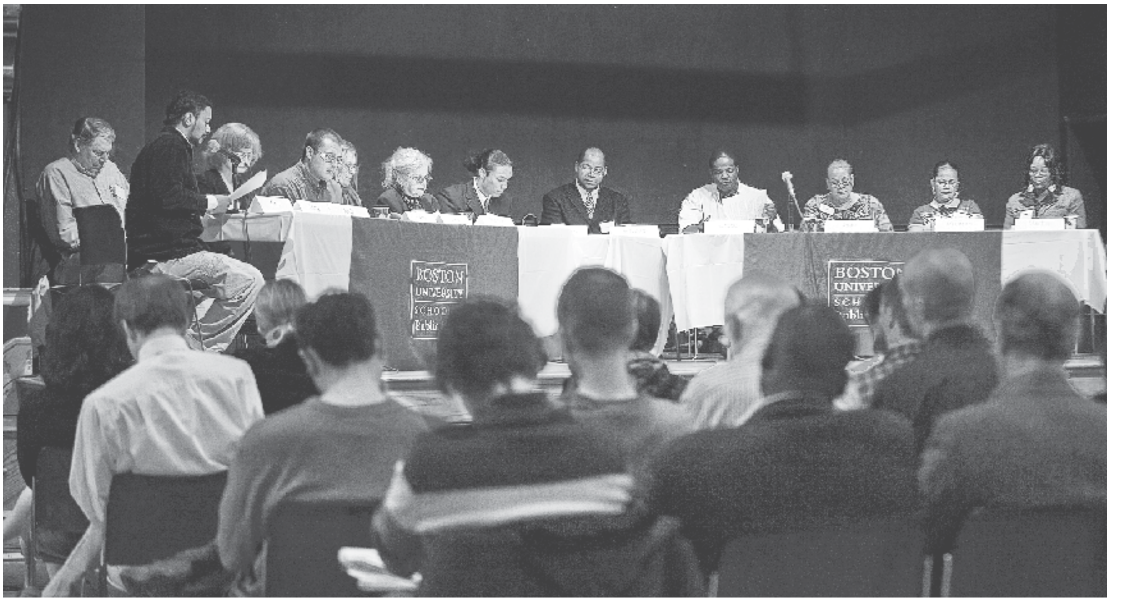
According to National Academy of Sciences Division Director Dr. Peter Blair, the NRC process is not generally well suited to seeking or reaching consensus involving fundamental value judgments or trade-offs.[187] Hence the NRC committee's limited ability, in some instances, to offer insight or answers regarding difficult ethical issues involving biomonitoring may represent a systemic limitation of the NRC process.

In comparison, the Boston lay panel presents itself as more emotionally invested and incisive on ethical matters, announcing at the outset that biomonitoring "'hits close to home' for many of us," and later insisting on a protocol that "fully educates the participant about the potential implications of opting in or opting out of receiving their test results." Wishing in particular to prevent discrimination, the lay group advanced the novel recommendation that biomonitoring data "should be statutorily exempted from being transmitted or shared with employers, insurers or others as part of the medical history, without the express written consent of the individual."[188]

The NRC committee noted that biomonitoring studies can be designed to investigate the "environmental injustice" hypothesis that low-income groups and racial or ethnic minorities are disproportionately exposed to environmental chemicals. The Boston participants went a step further, expressing the hope that biomonitoring programs will encourage greater "corporate and government responsibility" in such cases.[189]

The NRC study dwells on the "vexing challenge" of communicating with the general public in a way that provides useful information without provoking undue alarm. In comparison, the Boston lay panel was more wide-ranging in its social concerns, and more explicitly concerned with empowering people and communities to guide their own fates. The Boston group emphasized educating the general public to be able to make more informed health-related decisions, anticipating that for many people participation in biomonitoring "could create an introduction . . . to the health care system itself" and "foster a positive attitude toward preventive health care, not just occasional use of the system for crisis situations." Attentive to distributive justice, the Boston participants were especially concerned that usable information should reach the "populations most in need" of it – "being attentive to geography, socio-economic class, and ethnicity and sensitive to issues of accessibility (e.g., language and TV/computer access)" – and "making sure that an infrastructure is in place to support people's reactions to what they learn, and providing follow-up services."[190]

The lay panel went beyond the NRC in considering political-economic issues and sociotechnical dynamics, warning that oversight boards for biomonitoring should "not be dominated by industry" and expressing the hope that biomonitoring data could be used to stimulate "'green chemistry,' the development of alternatives to potentially toxic and persistent chemicals" and "'green companies' . . . that would create new jobs and markets . . . and promote a healthier environment."[191] The NRC report



The concluding public presentation by the lay panel of the Boston Consensus Conference on Biomonitoring, 11 December 2006. The audience included journalists and representatives from Massachusetts State Senate offices, Governor-elect Deval Patrick's transition team, Boston and New Hampshire public health agencies and a chemical industry trade association, as well as community and environmental organizations, academic researchers and students. (Photo by Lisa Kessler).

doesn't consider the possibility that biomonitoring studies could be used to catalyze economic system transformation of this kind.

In addition, the Boston lay panel recommended that "biomonitoring data that show an increasing trend in exposure to a chemical, even when the health effects are uncertain, should be treated in a precautionary manner that seeks to reduce or eliminate exposure. . . ." On that score, the NRC report seems generally more concerned to manage or limit popular apprehension rather than to promote precautionary actions (e.g., "giving people options for individual action is often a good way to . . . reassure people enough to forestall such personal action").[192] Moreover, while broader social considerations are front and center in the lay panel's succinct consensus statement, the NRC study mentions environmental justice, potential precautionary actions and stakeholder or citizen partnership in biomonitoring project design only in its dense background text, not in the all-important summary chapter at the front.

The fact that the NRC experts and Boston lay panelists, while in no sense diametrically opposed, nonetheless in some instances emphasized different sub-issues, developed different analytical insights and policy recommendations and reached different ethical judgments – e.g., concerning application of the precautionary principle or how to communicate with the lay public – does not establish that the judgments of one group are necessarily better than those of the other. It is, however, at a minimum illuminating to see how the judgments of an expert group contrast with those of a demographically diverse and balanced group of laypeople, and to furthermore observe that the analytical capabilities of consensus conference lay panelists do not obviously suffer in comparison with those of elite technical experts. Reading the two reports side by side is, in my view, indeed more informative and thought-provoking than reading either by itself (reinforcing the suggestion – in Sect. 5, above – that expert and participatory TA are complementary approaches).

It is also noteworthy that the two reports exhibit certain characteristic asymmetries in their judgmental styles. For example, as is often the case when comparing technical expert and lay analyses,[193] the Boston lay panelists are repeatedly sensitive to unequal power relationships – e.g., between, on the one hand, individuals, low-income communities or communities of color and, on the other hand, corporations or government. The lay group tends, in such instances, to be particularly attentive to the interests of the former, that is, to the interests of the perceived underdogs, with whom they can perhaps more readily identify. The NRC panel, in contrast, generally takes little note of power inequalities – and never identifies the groups or institutions with the upper hand – and thus sidesteps the possibility of making a preferential judgment. Likewise, there are repeated instances in which, while observing that a prior ethical judgment needs to be made, the NRC report defers that judgment to others (typically to other experts, researchers, professional ethicists or scholars of lay psychology).[194] In contrast, when the Boston lay panel sees an ethical judgment to be made, members never hesitate to provide their own considered opinion.[195]

A concurring opinion on the complementarity of the reports from the NRC and Boston lay panel comes from Professor Thomas Burke of the Johns Hopkins Bloomberg School of Public Health, who chaired the NRC study and also served on the steering committee for the Boston consensus conference. During the concluding public session of the consensus conference he commented publicly, "I think this panel has shown – to some degree of surprise to the scientific community – that the public can really understand the issues, and this panel has moved biomonitoring forward."[196]

In short, the Boston consensus conference on biomonitoring provides grounds for expecting insightful attention to ethical and social considerations in U.S. implementations of pTA, complementing and enriching expert analysis. Other U.S. pTA exercises have demonstrated similar results.[197] The evidence suggests, in other words, that U.S. citizens can match their Danish counterparts in competently executing the tasks demanded of them in a pTA exercise.

D. Experts, Laypeople and the Common Good

One occasionally finds pTA enthusiasts who believe that the propensity to seek and advance the public interest or the common good is a virtue inherent in the hearts, minds and souls of individual laypeople.[198] However, it is more probable that the propensity of a consensus conference–type format to offer an approximate representation of the common good is intrinsic to the *structure* of the process, not to the psychology of individual laypersons.

The term "common good" includes, but is not limited to, important but diffuse societal interests that are not well represented by organized stakeholder groups (see Box 6, above) and that, in many cases, are also not well represented by expert committee processes (see Box 3 and Appendix section C, above). Looming large among such diffuse and under-represented interests tends to be our shared interest in establishing and perpetuating the basic structures essential to a healthy democratic society.[199]

When one asks a balanced group of experts to prepare a consensual report, they are apt to find their way toward common ground based in part on the shared concepts, norms and practices of their professions, on certain shared material interests and social characteristics and on their wish to produce a study that will be influential. These various common interests encourage them to suppress evidence of their individual and shared subjectivity in favor of (giving an appearance of) dispassionate objectivity. In the process, they sacrifice some of the important insights that normatively informed vision, ethical reasoning and other forms of subjectivity can bring, even while their report invariably remains influenced latently in various ways by their subjectivity.[200]

However, even if a diverse and balanced group of experts overcomes their reticence to disclose their latent subjective and normative inclinations, their shared interests and characteristics continue to render them distinctively unrepresentative of the wider population in terms of values, concerns, life experiences and so on. Thus they still do not qualify as stand-ins for that wider population in striving to discover and articulate a balanced and informed representation of the common good.

In contrast, a consensus conference brings together a demographically diverse and balanced group of laypeople. The process shows great and unaccustomed respect for these people and for the dignity inherent in their role as citizens. It does this in part by offering lay panelists extensive organizational and staff support, as well as the opportunity to interact on terms of mutual respect with distinguished experts and to perform a public service in a very public setting (e.g., presenting recommendations for policy-makers in a concluding press conference). The search for areas of agreement among a diverse and balanced lay panel tends to cancel some of the particularity and idiosyncrasy of different personal points of view (although evidence of such diversity and points of disagreement may be identified and honored).[201] What remains is a residual shared subjectivity of common values, goals, life experiences and concerns – in other words, the common good, at least as perceived by the members of this particular lay panel.[202] Moreover, experience suggests that the respect that such a process accords the lay participants tends, in turn, to elicit from them their higher, more ethical, more civic-oriented selves, in contrast with the many other more narrow and particular social roles that each of us may play throughout our ordinary days as, say, a boss, worker, consumer, investor, homeless person, spouse, parent, student, neighbor. or weekend athlete.[203] This would explain the not-infrequent observation, during the concluding layperson press conference, of audience members wiping away a few tears: something unusually beautiful and ennobling is being witnessed, and the audience responds to that.

That these results are structural rather than intrinsic to individual psychology is underscored by the fact that consensus conference lay panels sometimes include one or two credentialed experts – although no experts in the topic under consideration. That is, organizers have found no objection to including an occasional astrophysicist or transportation engineer on the lay panel of a consensus conference dealing with, say, human genetic engineering. Inasmuch as astrophysicists and transportation engineers, as such, have no expertise in genetics, in this setting they are *not* expert, and may therefore prove as adept as other members of the lay panel at slipping naturally into their role as lay citizens. Thus the same people who, in their professional lives, might behave as typical technical experts and suppress outward evidence of their ethical concerns and moral and civic sensibilities, may nonetheless – as members of a consensus conference lay panel – default to their role as morally engaged citizens concerned with articulating ethical concerns and advancing the common good of all.

Note, too, that if experts are individually and collectively incapable of discovering and articulating the common good, a fully representative group of lay people likewise cannot do it all by themselves. In order to tackle the complex kinds of topics addressed in pTA, laypeople need an opportunity to learn from or with experts. Hence if pTA entails demoting experts somewhat from their accustomed exalted and highly empowered status, it continues to honor them as essential contributors of knowledge and insight.

E. On Innovation in Expert and Participatory TA Concepts and Methods

Andy Stirling of the University of Sussex distinguishes expert TA and pTA that tend to "close down" the range of evaluative considerations and policy options – thereby narrowing down to a small subset of possible courses of action – from expert TA and pTA that "open up" a wide range of interpretations, considerations and opportunities for guiding sociotechnological trajectories.[204] "Closing down" and "opening up" can both have their proper place in policy analysis and politics, but Stirling cautions against an unexamined tendency to opt for TA process designs that privilege "closing down." While the OTA normally presented a range of policy options for Congress to consider, the agency's weakness in addressing social and ethical considerations, synergisms and dynamics – coupled with relying over time on a highly standardized report-preparation-and-review procedure, and inattention to academic innovation in the social understanding of technology and innovation – positioned the agency closer to the "closing down" pole of the closing down/opening up continuum.[205] Accordingly, ongoing innovation in concepts and methods is required in the interest of developing a U.S. expert-and-participatory TA capability that does not slight opening up and expanding possibilities for democratically guiding sociotechnological trajectories.

Regarding the integration of pTA into policy-making, to date U.S. pTA exercises have been organized as university-based research-and-demonstration projects that have had limited or no linkage to government policy-making bodies.[206] That has made sense for the purposes of methodological development and procedural testing, and for the creation of public awareness and understanding of pTA. However, there are hazards in continuing to undertake such exercises if they are not gradually integrated into actual government, industrial or other societal decision-making processes. pTA or other citizen-deliberation processes that have no opportunity to influence policy decisions or sociotechnological outcomes could at some point become a waste of money and effort, and certainly run the risk of producing frustration, alienation or anger among participants who have devoted considerable time and effort to them.[207]

Suggestions for integrating pTA into government decision-making include asking government bodies that commission a pTA project to refrain from making a pertinent policy decision immediately prior to learning the results, and to respond formally to those results. The latter has in some instances been a contractual requirement agreed to by local authorities in the United Kingdom when commissioning organization of a citizens' jury (a process similar in a number of respects to a consensus conference). This does not mean that legislators or other officials should necessarily accept and implement pTA recommendations; they should, however, give such recommendations fair consideration. Another possibility is to involve decision-makers or their staff members directly in pTA processes. The OTA developed a measure of legislative influence through various procedures and structures, including having a bipartisan board of directors, called the Technology Assessment Board, composed of six U.S. representatives and six senators.[208]

Other analysts have suggested mechanisms for integrating both expert and participatory TA processes or results into government decision-making via indirect avenues (e.g., via stimulating or informing popular debate) and into non-governmental decision-making arenas, such as university R&D laboratories, corporate decisions and consumer and citizen choices.[209]

Many experiments with pTA are already under way. New methods are emerging that rely more heavily on Internet mediation than on face-to-face deliberation. These methods warrant comparative evaluation to see what works and what doesn't, and what is gained and lost when there is less reliance on face-to-face meetings.[210]

In fleshing out their preferred or unwanted futures within the context of a forward-looking TA exercise, laypeople sometimes remain within the possibility space defined by the range of expert and stakeholder input to which they've been introduced. For that reason, it is important that the breadth of future options and scenarios presented to lay participants in a pTA process (or to decision-makers, for that matter) be adequately expansive – i.e., not constrained by the values, life experience, interests, political objectives, world outlooks or imagination of an arbitrarily narrow range of expert analysts and stakeholder representatives.[211]

In this regard, TA might benefit from skillful inclusion of highly passionate public intellectuals, social activists or social critics of science and technology (whose passionate subjectivity and particularistic values can enable them to push the envelope on identifying technological synergisms and positive and negative social eventualities), or even of other kinds people with demonstrated imaginative gifts, such as novelists, science fiction writers, poets, filmmakers and musicians.[212] The historical success of some science fiction writers in anticipating future developments in science and engineering, and their social implications, is suggestive.[213]

TA stages such as scenario construction, analysis, peer review (and sometimes problem framing) have traditionally been accomplished by in-house expert teams or small advisory groups. To incorporate a wider range of views within these stages, open or partially open online collaboration – e.g., wiki-style – may prove useful.[214]

The evolved European division of labor between expert and participatory TA sometimes takes it for granted that analysis is primarily an appropriate activity for experts, whereas laypeople can fruitfully contribute to deliberation and normatively informed judgment.[215] This formulation tends to slight lay contributions to analysis. Moreover, one hazard in allowing analysis to be preponderantly the domain of experts is that crucial value judgments may be latently incorporated into that analysis, out of sight of critical social scrutiny.[216] Advances in recent decades in "community-based participatory research" suggest that it may be possible to develop methods for involving laypeople more strongly in the analytic phases of technology assessment.[217]

Historically, TA has focused especially on emerging technologies. It can also be valuable to compile, conduct or commission retrospective studies of existing and previous technologies. Such studies would not only offer insight into how existing technologies affect societies but also provide a stronger basis for conducting forward-looking TA.[218]

Any new TA institution would, in general, benefit from developing a capacity to monitor, encourage or solicit and – as appropriate – integrate emerging developments in the scholarly understanding of technology-and-society relationships for insights that can potentially assist in conceptualizing, conducting or making use of technology assessments. For instance, actor-network theory and social construction of technology perspectives, developed over the past quarter-century, may aid in identifying new contexts, modalities and points of entry for civil society or government engagement in guiding sociotechnological development.[219]

Notes

1. Journalist Howard Rheingold is quoted in Chapman (1995). The history of the U.S. OTA is discussed in Bimber (1996, chaps. 3-7); Bimber and Guston, eds. (1997, pp. 125-198); and Morgan and Peha, eds. (2003a, chaps. 1-4). Archives of the former OTA are online at www.princeton.edu/~ota and www.fas.org/ota (accessed 15 Oct. 2009).

2. See, for example, Rodemeyer (2005) and and Sarewitz (2005).

3. See recent scholarly and practical perspectives on anticipatory governance, such as Barben et al. (2008); Guston (2008); and Hartzog (no date).

4. Sclove (1995b, especially chaps. 1, 2 and 13). See also Sclove (1995b, pp. 53-56), as well as Guston (2008), which counter the claim that beneficially guiding technological development depends upon an implausible level of success in long-range prediction.

5. On the development of the U.S. automobile system and culture, including its less salutary aspects, see, for example, Flink (1988); Jackson (1985); and Sclove and Scheuer (1996). On the U.S. industrial agriculture system and its health implications, see, for example, Pollan (2008) and Kessler (2009). The seminal modern critique of the development of the U.S. energy system has been Lovins (1976). On the entrenchment of light water nuclear power reactors see, for example, Cowan (1990).

6. Additional adverse effects of the U.S. pattern of automobilization have recently been addressed in depth by Lutz and Fernandez (2010).

7. E.g., Miller (1989, especially chaps. 11 and 25). See also Sclove and Scheuer (1996, p. 610) and Sclove (2004, pp. 37-38).

8. On energy policy, global warming and a green economy see, for example, Friedman (2009). On synthetic biology, see Parens et al. (2009).

9. Margolis and Guston (2003, pp. 68-69). These cost figures have been adjusted for inflation into 2009 dollars using the calculator at www.usinflationcalculator.com.

10. Margolis and Guston (2003, p. 65) and Bimber (1996, p. 33). These cost figures have been adjusted for inflation into 2009 dollars using the calculator at www.usinflationcalculator.com. Grifo (2010, pp. 2-3) offers additional evidence supporting the cost-efficacy of OTA analysis.

11. Adler et al. (2008, p. 10). Similar claims appear in Gordon (2006) and in Morgan and Peha, eds. (2003a, pp. 7-8, 174).

12. E.g., Barley (2007).

13. E.g., Thackray (1998) and Krimsky (2004).

14. Shapin (2008, p. 13).

15. Singer and Wilson (2009).

16. Sclove (2004, p. 42).

17. Quoted in Lepkowski (2001). Further provocative thoughts on the idea of organizing selected TA activities on the basis of an open-source network model appear in Rejeski (2005). See also Wood (1997, p. 158) and Kriplean et al. (2009).

18. MASIS Expert Group (2009, p. 35).

19. See generally the website of the European Parliamentary Technology Assessment network, www.eptanetwork.org; Vig and Paschen, eds. (2000); Decker and Ladikas, eds. (2004); and MASIS Expert Group (2009, pp. 35-37 and 66-68). On European *participatory* TA methods, see Klüver et al. (2000) and, while not specific to TA, Elliott et al. (2005) and Hagendijk et al. (2005). For examples of *transnational* participatory TA, see "Meeting of Minds: European Citizens' Deliberation on Brain Science," a citizen-deliberation project that spanned nine European nations (www.meetingmindseu rope.org); Boussaguet and Dehousse (2008); Abels (2008); the World Wide Views on Global Warming project, described in Appendix section B(iii), below; and the cost comparison in Box 10, below. Websites accessed 9 Sept. 2009. On the broader context of public participation in European government and civic affairs, see *Public Participation in Europe* (2009).

20. Klüver et al. (2000). Klüver and Hoff (2007, pp. 61-74) provide summary descriptions of a wide array of European TA methods, including expert, participatory and hybrid approaches. Appendix section B(iv), below, summarizes a U.S. adaptation and elaboration of a European pTA scenario workshop. Jensen (2005) briefly describes the development space method and gives a critical analysis of one application; Burgess et al. (2007) describe a participatory deliberative mapping exercise.

21. Lars Klüver, Director, Danish Board of Technology (and 2010 president of the European Parliamentary Technology Assessment network), telephone conversation and e-mail with Richard Sclove, 1 March 2010; and MASIS Expert Group (2009, p. 66). The new European Community REACH strategy for regulating chemicals is presented on the website http://ec.europa.eu/environment/chemicals/reach/reach_intro.html; the REACH strategy was stimulated in part by a Danish Board of Technology TA project on non-assessed chemicals in the European Union (see www.tekno.dk/subpage.php3?article=298&language=uk&category=11&toppic=kategori11).

22. MASIS Expert Group (2009, pp. 35, 67).

23. Decker and Ladikas, eds. (2004).

24. The quote is from a member of the Danish Council of Industry and appears in Cronberg (no date), p. 11. According to the recent report of the MASIS Expert Group (2009, p. 35), "high-tech companies faced with uncertain public reactions are willing to participate in TA activities." The Novo Nordisk example is from Lars Klüver, Director, Danish Board of Technology, telephone conversation with Richard Sclove, 2 Aug. 1995. The Danish Board of Technology (DBT) has on file letters from Danish government, industrial, professional and civil society organizations that were sent in May 2007 to the Danish Minister of Science and Innovation, expressing approval for Danish pTA (Lars Klüver, e-mails to Richard Sclove, 5 and 17 June 2009). For instance, from Lars Bytoft Olsen, Chairman of the Association of Danish Engineers: "The DBT has during the latest decades given perspective and nuances in the debate on technological development, which we regard as crucial in times where much is invested in technological progress and where acceptance of such investments into science and technology is needed from the population. . . ." See also Sclove (2000, p. 39).

25. Adapted from Sclove (2000, pp. 33-36). For further information on consensus conference methodology, see Joss and Durant, eds. (1995) and Kleinman et al. (2007). Blok (2007) is a recent study of Danish consensus conferences. A Danish-style consensus conference must be distinguished from "consensus conferences" that are organized under the auspices of the U.S. National Institutes of Health (NIH); the latter seek consensus among medical experts rather than laypeople. See the NIH Consensus Development Program, described online at http://consensus.nih.gov/ABOUTCDP.htm (accessed 4 Aug. 2009). The Danish Board of Technology acknowledges having borrowed the term "consensus conference" from the NIH.

26. Adapted from Sclove (2000, pp. 36-39), drawing in part on Joss (2000) and INRA (Europe) and the European Coordination Office SA/NV (1991). For additional discussion of the societal influence of European pTA, including how to conceptualize such influence, see Klüver et al. (2000, pp. 135-168); Decker and Ladikas, eds. (2004); and Klüver and Hoff (2007). For some other examples of pTA influence, see Appendix section B, below.

27. Lars Klüver affirms that over time Danish pTA methods have grown increasingly influential in policy-making. In the 1980s, when pTA methods were new, they sometimes garnered greater media coverage because of that novelty. Nonetheless, Klüver judges that DBT pTA processes are today more influential in Danish policy-making than they were in the 1980s and 1990s (personal communication with Richard Sclove, 30 Sept. 2009).

28. An extensive list of Danish-style consensus conferences that have been conducted around the world is listed on the website of The Loka Institute at www.loka.org/TrackingConsensus.html (accessed 17 Sept. 2009). Recent studies of consensus conferences organized outside of Denmark include Einsiedel et al. (2001); Goven (2003); Nielsen et al. (2007); Dryzek and Tucker (2008); and Dryzek et al. (2009).

29. The Obama administration's actions to promote citizen engagement in governance can be tracked through several websites: (1) The new federal Office of Public Engagement (www.whitehouse.gov/ope); (2) the Open Government Initiative (www.whitehouse.gov/open); (3) the Office of Science and Technology Blog (blog.ostp.gov); (4) the Open Government Dialogue of the National Academy of Public Administration (http://opengov.ideascale.com) – all accessed 4 Aug. 2009; and (5) www.data.gov (accessed 9 Sept. 2009). See also the administration's Open Government Directive, which was issued on 8 Dec. 2009 (Orszag 2009, especially pp. 9-11).

30. Wood (1997) and Margolis and Guston (2003), as well as an appreciation by Republican Congressman Amo Houghton (1995).

31. Bimber (1996, chaps. 3-6).

32. There is some disagreement about exactly how long it took OTA to complete a study on average. Bimber (1996, p. 34) says "about two years." Margolis and Guston (2003) say that it "often took two years or longer" (pp. 63 and also p. 64) or, modestly contradicting themselves, "typically 1-2 years" (pp. 71-72 and also p. 65). U.S. Congress, Office of Technology Assessment (1993, p. 42) found that for the 18 OTA studies that it evaluated, the average time to prepare and issue a final report was 26 months: "Unfortunately, though, information on elapsed time from approval of request by the Technology Assessment Board (TAB) to report release is unreliable because of imprecise record keeping and other reasons. . . ." Others argue that if one takes as the start date not when an OTA team began its work, but when a congressional committee chair first sent a study request to the OTA, the total time to completion could be three or more years

    Some OTA defenders (e.g. Hill, 2001) point out that the OTA made efforts to address this concern by providing interim reports and advice when Congress needed information quickly. The trade-off involved with this solution was that it then belied OTA's claim that its careful report-review process ensured that its advice to Congress was balanced, impartial and comprehensive.

    Epstein (2009) observes that "a look back shows that rather than being late, OTA had considered many issues with depth and perception long *before* they came to the general attention of legislators" (emphasis in the original). That's a reasonable claim; a number of OTA studies were indeed far-sighted and have held up well with the passage of time. Nonetheless, it does beg the question of instances in which OTA reports arrived on the scene after Congress had already decided a particular issue.

33. "OTA's reputation for objectivity is viewed by some as one of its chief assets" (U.S. Congress, Office of Technology Assessment, 1993, p. 42; see also pp. 35-37). "The Agency [OTA] assembled an advisory panel of stakeholders and experts for each major study to ensure that reports were objective, fair, and authoritative" ("Assessment Process," no date). A more recent advocate of re-opening the OTA argues that "by leaving out the value judgments and prescriptive recommendations, OTA was able to be both authoritative and credible." (Grifo, 2010, p. 4). See also Dickson (1984, pp. 233-234) and Margolis and Guston (2003, p. 63).

34. E.g., Rorty (1979); Bernstein (1983); and Latour (1999).

35. E.g., Bimber (1996, pp. 3-5, 12-14, 22, 97).

36. Decker and Ladikas, eds. (2004, pp. 1-2, emphasis in the original; see also pp. 36-37).

37. E.g., Sclove (1995b, pp. 48-53 and 173-178) and Sclove (1982). For an astute early critique of the values embedded and omitted in OTA-style expert TA analysis, see Henderson (1996, pp. 327-338), which is a revision of arguments originally published in 1975.

38. See Box 5 and Appendix section C(i), below.

39. See Appendix section C(i), below.

40. Quoted in U.S. Congress, Office of Technology Assessment (1993, p. 71). See also Bereano (1997); note 59, below; and Sclove (1989, especially pp. 181-182). U.S. Congress, Office of Technology Assessment, *Perspectives on the Role of Science and Technology in Sustainable Development* (1994) is an example of an OTA study that did draw effectively upon dissident perspectives (see note 44, below).

41. See Appendix section C(i), below. There are certainly exceptions to this generalization. E.g., U.S. Congress, Office of Technology Assessment, *Automation of America's Offices* (1985), looked at the effect of automation upon the quality of work life in conventional workplaces, in homes, offshore and in government, including effects upon women

and minorities. The analysis was conceptually quite broad and comprehensive, although there was in general more attention to objectively measurable issues (such as productivity, health effects and stress) than to more subjective or potentially conflictual issues (such as job satisfaction and labor-management relations). One can hypothesize that had a sample of affected workers been involved in informing, preparing or reviewing the study, the relative emphasis might have been different. And while the OTA study gave some mention to issues of de-skilling versus creativity and job satisfaction in automated workplaces (e.g., pp. 18-19 and 101-108), there was no effort to explore the potentially deeper social and democratic implications of these issues for worker psychological, moral and political development and for citizenship (compare Sclove, 1995b, especially pp. 90-98, but also pp. 15-16, 42-44, 100-109, 113-118 and 162-164).

42. Sclove (1995b, especially chaps. 1-3, 9 and 10, and pp. 216-222). An early and important critique of TA concepts and methods that began to develop insights along these lines is Tribe (1973). Tribe's insights were notable not only on their merits but also because he had previously staffed an influential National Academy of Sciences report that helped inspire the establishment of OTA in 1972 (Committee on Science and Public Policy, National Academy of Sciences, 1969). See also Wilsdon (2005).

43. Sclove (1995b, especially pp. 23, 53-56, 155, 194-195, 221 and 239-40); Sclove (1999); and Fisher et al. (2006, p. 487). Sarewitz (2005) argues on theoretical grounds that assessing the social effects of suites of multiple technologies is an impossibly complex undertaking. However, European scenario workshops represent one pTA method that has already demonstrated a capacity to undertake this task; see the summary description of the Lowell scenario workshop in Appendix section B(iv), below; Sclove (1999); and Andersen and Jaeger (1999). See also Box 5, below, including the examples of social movements that have already demonstrated success in both evaluating and influencing multiple technologies.

In a related vein, the MASIS Expert Group of the European Commission (2009, p. 35) observes, "In current TA it is not just a question of the consequences of individual technologies, products or plants, but of complex and conflictual situations between newly emerging science and technology, enabling technologies, innovation potentials, patterns of production and consumption, lifestyle and culture, and political and strategic decisions."

44. OTA publications in the year 1994 are archived online at www.princeton.edu/~ota/ns20/year_f.html (accessed 10 Aug. 2009). The exceptional 1994 OTA study that took into account multiple kinds of technologies, interpreted from multiple, conflicting normative points of view, was *Perspectives on the Role of Science and Technology in Sustainable Development* (1994). This study was atypical in several respects. For instance, it was a study of technology in developing societies, not of the United States. In addition, it was informed by an outside working group that included several of the nation's leading environmental and social critics of conventional economic and development theory and practice (e.g., Herman Daly, Paul Ehrlich, David Korten and Donella Meadows; see p. 65).

45. Sclove (1995b, pp. 15, 21-23), drawing on the insights of Lee (1959, p. 31); White, Jr., (1974); and Elias (1978). Recent social networking Internet sites, such as Facebook, offer an interesting twist to this pattern. Facebook reflects and supports individualism, but diminishes personal privacy. Perhaps this provides some antidote to the sense of social isolation that can come in the wake of the modern deconstruction of traditional local community life.

46. My perspective challenges that of analysts who contend that neutrality, objectivity and value-free analysis, even if never fully attainable in practice, are desirable ideals toward which technology assessment should always aim. For example, Granger Morgan (2002) concedes that "there is no such thing as 'value-free analysis.'" However, he continues, "There is also no such thing as living a life without sin . . . but peoples of the world have long seen this as an admirable objective toward which to strive. Policy analysts should do the same with respect to values."

47. Appendix section B(iv), below, summarizes an example of a pTA exercise in Lowell, Massachusetts, that overtly evaluated synergism among multiple technologies using the norms of attaining urban sustainability (both environmental and economic) and a vibrant democratic civil society.

Lars Klüver, director of the Danish Board of Technology, proposes that studying multiple technologies becomes possible when one does broad, "problem-oriented" TA – e.g., "Technology and Urban Sustainability" or "Technology and Obesity" (personal communication with Richard Sclove, 29 June 2009; see also Decker and Ladikas, eds., 2004, pp. 22 and 71). Inasmuch as "problems" are defined by underlying norms or social values, this is not saying something entirely different than that normatively informed TA is capable of addressing synergisms. However, problem-oriented TA can sometimes be rather narrowly focused in normative terms – e.g., looking at the multiple technologies that affect human obesity (substitution of machinery for human physical labor; substitution of television, videos and the Internet for physical recreation; scientific design and industrial production of foods engineered to promote over-eating and food addiction and so on), while overlooking the other non-weight-related social effects of those same technologies. Of course, any given TA study needs to have practical boundaries. But if those boundaries are too narrow, public policy may miss opportunities to efficiently address multiple issues or causal factors at once.

Somewhat contrary to Klüver's contention, it is noteworthy that while the OTA frequently conducted problem-driven TA (U.S. Congress, Office of Technology Assessment, 1993, pp. 10 and 44-45), the agency did not as a result develop a significant capacity to study synergisms among multiple technologies. Thus if problem-driven TA allows study of synergisms, it certainly does not necessitate or, by itself, even strongly encourage it.

Studies of so-called convergent technologies, as in the National Citizens' Technology Forum on Nanotechnology and Human Enhancement (see Appendix section B(ii), below), represent a subset of what I mean by synergisms. Convergent technologies are brought to bear in combination and more or less intentionally on a problem or area of human need. This is not same thing as when multiple unrelated technologies produce combined indirect or unintended effects. Moreover, when studying convergent technologies, it may also be important to consider whether additional technologies are indirectly influencing the outcomes.

"Deliberative mapping" may offer promise as one tool, or at least proof of concept, for deploying multiple normative orientations within an expert TA or pTA process; see Burgess et al. (2007).

48. Sclove (1995b, pp. 13-15). See also Lehoux and Blume (2000).

49. E.g., Bimber (1996, p. 22) and Byerly (2002).

50. Renn et al. (1995b, p. 357) point to a corollary concern: businesses, government agencies and technical experts sometimes reframe a normative conflict as though it were technical, forcing citizen participants to suppress their moral or value-based concerns or to contort those concerns so that they conform to the standards and language of technical reasoning.

51. See, for example, Stern and Fineberg, eds. (1996, pp. 39, 45-46); Wynne (2005); Felt et al. (2007, chap. 3); and Levidow (2007). On the role of sacred values in technological politics see Sclove (1995b, pp. 157-160) and Noble (1997).

52. Sclove (1995b, pp. 119-121), drawing on the research of Tarr (1988) and Frug (1980, especially pp. 1139-1140 and 1065).

53. Sclove (2004, pp. 38-47).

54. The lawn mower, car and bicycle and electricity and energy-conservation examples are from Sclove (1995b, pp. 14 and 166; an additional historic example involving automobiles appears on p. 165). Examples of how the Internet can potentially coerce people to use it in ways, or to an extent, that they would rather not, and with adverse consequences for offline community life and democratic civil society, are discussed in Sclove (2004, pp. 39-41 and 43-44).

55. See, for example, Cowan (1990); David (2000); Nahuis and van Lente (2008); and Latour (2007). I have elsewhere addressed such sociotechnological dynamics using the concepts of "coercive and seductive economic externalities" (Sclove, 1995b, pp. 165-167) and "coercive compensation" (Sclove, 2004, pp. 39-40, 42 and 46-47).

56. E.g., Gray (2006) and Kessler (2009).

57. Wood (1997, especially pp. 146-147, 153 and 159).

58. See also Wood (1997, p. 159) and Guston (2003, pp. 78-81). The OTA routinely called upon academics with substantive expertise in a particular technology under investigation, but remained inattentive to more general and theoretical scholarly studies in science, technology and society interrelationships.

59. E.g., Gibbons (1982, p. 50), "Assessment Process" (no date). Former OTA staff member Dr. Daryl Chubin, reacting to a preliminary draft of the present report, labeled "the charge of no citizen participation . . . outrageous. . . . The OTA process was nothing if not participatory. The most telling criticism [of an OTA report] was when a stakeholder claimed his/her voice was not solicited as part of the process" (e-mail to Richard Sclove, 5 July 2009).

Bereano (1997) discusses limitations in how the OTA applied stakeholder representation in practice. In 1993 an internal team of OTA staff members conducted a comparative and critical review of 18 OTA studies, finding that about one-third (5) of the 18 reports in its sample did a very good or excellent job of analyzing the positions of different stakeholders in the analysis of "context, findings, and issues," but another third did only a poor or fair job in this area. In the analysis of "goals and options," about half (8) of the reports included some discussion of the support for options by, and the effects of options on, the stakeholders (including the American public). . . . (U.S. Congress, Office of Technology Assessment, 1993, p. 60).

According to former OTA staffer Fred Wood (1997, p. 158), "Public participation [by representatives of organized stakeholder groups] was one of the bedrock principles of the OTA assessment process. . . . Yet this aspect of OTA's methodology could be time consuming and still fall short of attaining fully balanced participation, while leaving some interested persons or organizations unsatisfied. The TA organization needs to experiment with alternative forms of public participation. . . ."

The OTA did experiment with participation by laypeople on rare occasion. See, for example, U.S. Congress, Office of Technology Assessment (1976, pp. 255-279). This early participatory attempt, while methodologically primitive by later European pTA standards, showed promise and was advanced for its time, but it did not become a model or inspiration for later OTA projects. See also U.S. Congress, Office of Technology Assessment (1991, pp. 59-60), a study of adolescent health services delivery that included an advisory panel of 21 youth ages 10 to 19.

Discussion of whether and in what form to include public participation within OTA activity was present from the very beginning; see, for example, Chalk (1974) and Bereano (1997, especially pp. 164-169).

60. Van Eijndhoven and van Est (2000, p. 114). Note that the cited report abbreviates participatory TA as "PTA" rather than "pTA." To maintain consistency throughout the present report, we have changed the abbreviation to "pTA" in this quoted passage.

61. On OTA's involvement of stakeholder representatives, see U.S. Congress, Office of Technology Assessment (1993, pp. 10, 60); Bimber (1996, pp. 65-66); Wood (1997, pp. 152-155 and 158); Bereano (1997); and note 59, above

The OTA was legislatively mandated to inform Congress about salient emerging developments in science and technology. In contrast, it is noteworthy that from its founding the Danish Board of Technology (DBT) – the Danish Parliament's technology assessment agency, which is a world pioneer in pTA methods – was directed to inform the Parliament about emerging developments in science and technology *and about what the Danish citizenry think, feel and recommend with respect to those development*: "From the beginning, the DBT has had a dual mandate to carry out comprehensive technology assessments and to further public debate and citizen participation on technological questions affecting society (in the Danish tradition of 'people's enlightenment')" (Vig, 2003, p. 93). On Danish "people's enlightenment" and its relationship to Danish innovations in pTA, see Horst and Irwin (2010).

62. On values being inescapable and necessary to technology assessment in general, and to OTA analysis in particular, Bimber (1996, p. 97) writes, "Experts do not necessarily supply information and analysis that is free of normative judgments. The 'facts' and understanding that experts provide are often not easily dissociated from underlying values. At many points along the continuum of scientific and technical discovery or learning are opportunities for experts to exercise discretion that is not strictly objective or 'scientific' in nature: in the choice and framing of questions, the adoption of theoretical or empirical models, the interpretation of sometimes ambiguous data, and in the phrasing and presentation of results." See also the quote from Decker and Ladikas, eds. (2004, pp. 1-2) in the preceding subsection titled "Myths of Expert Impartiality."

The preceding perspectives contrast with those of proponents of reviving the OTA as it was, such as Grifo (2010, quoted in note 33, above), who characterizes the OTA's analysis as "leaving out the value judgments."

63. Borgmann (1984, especially pp. 35-78).

64. See, for example, Daly and Cobb, Jr. (1989) or, for a more general overview of recent challenges to conventional economic analysis, Harvey and Garnett, Jr., eds. (2008). U.S. Congress, Office of Technology Assessment, *Perspectives on the Role of Science and Technology in Sustainable Development* (1994), which included Herman Daly in an advisory working group to the project (see note 44, above) and differed from most OTA studies in acknowledging critiques of, and social alternatives to, economic growth as conventionally defined.

65. Regarding the suggestion that the OTA process arbitrarily privileged certain values over others, see Box 3 (above, arguing that the values of the

expert community do not in general represent those of the wider citizenry) and Box 6 (below, arguing that even the inclusion of a balanced group of organized stakeholder representatives within a TA process is often insufficient to reflect the value spectrum of the wider citizenry, including important but diffuse interests that are not represented by any organized interest group).

Bimber (1996, p. 51, 97) observes that "OTA developed a *strategy of neutrality* [that] embraced neutrality not as a professional standard but as a political survival strategy to ward off critics. . . ." (emphasis in original). Furthermore, "It is not the case that experts at OTA had no values, no opinions, no position on policies. What is interesting is that the agency chose not to reveal those positions in its work."

John Gibbons, the third director of the OTA, explained that in pursuit of a strategy of neutrality, the agency sometimes made sure to provide Congress with an even *number* of policy options, so that it would not appear that OTA was tacitly in favor of a "middle" option. See van Dam and Howard (1988, pp. 46-51) and Bimber (1996, p. 66).

66. See, for example, the political philosopher Jürgen Habermas (e.g., 1982), who argues that the challenge in a democratic society is to find processes that allow a reasoned contest, not distorted by power asymmetries, among competing normative orientations; the phenomenological philosopher Don Ihde (1983, chaps. 5 and 7), who argues that a perception or description is more adequate when it is fuller and richer; and note 62, above.

67. Sclove (1995b, especially chap. 3 and p. 222). Appendix section B(iv), below, summarizes one practical attempt to operationalize prioritized attention within TA to the structural conditions of democracy; see also note 117, below.

68. At least one OTA project stands as a noteworthy exception to this generalization. In honor of the bicentennial of the U.S. Constitution, the House Judiciary Committee asked the OTA to conduct a study of "Science, Technology, and the Constitution in an Information Age." The study attempted to catalog direct technological impacts on principles enshrined in the U.S. Constitution and – unusually for an OTA project – along the way it made some headway in addressing the combined political effects of disparate technologies. The project was less successful at identifying combined *indirect* structural political effects of technologies, although here again an important exception involves the study's tantalizingly brief mention of some important ways in which the development of large-scale technological systems has prompted expansion and reorganization of the federal government, and transformed the balance of power between the government and private corporations and between local, national and international political arenas; see U.S. Congress, Office of Technology Assessment (1987, pp. 4-9). A noteworthy weakness in this otherwise important and illuminating OTA analysis is that it is framed in the technological-determinist terms characteristic of early congressional and parliamentary TA (see Fisher et al., 2006, p. 487). The OTA study presents constitutionally consequential repercussions of past technological change with no sense of the social *contingency* of those results, that is, of ways that the adoption of alternative available technologies; of different technological designs, configurations and operating procedures; or of different accompanying institutions might have resulted in quite different social and political effects (see Box 4, above). On social contingency in technological innovation and its results, see Sclove (1995b, pp. 17-19); Bijker et al. (1987); and Feenberg (1991).

Other reports from the OTA project on science, technology and the constitution include U.S. Congress, Office of Technology Assessment (1988a, 1988b, 1988d). One example of an indirect structural effect that escaped the OTA study's attention is the danger that actual or threatened catastrophic acts of technological sabotage or terrorism could prompt a preventive governmental response that includes diminished protection of civil rights and liberties and human rights. We have seen an instance of this in the George W. Bush administration's response to Al Qaeda's use of hijacked jet airplanes to destroy the World Trade Center (e.g., domestic wiretaps of dubious legality, suspension of habeas corpus and torture of foreign prisoners). But the more basic issue of technologically based threats to civil freedoms was identified well before the OTA study; see, for example, Lovins and Lovins (1982, pp. 25-27, 160, 174 and 204-205).

69. See Sclove (1995b, pp. 194-195 and 243).

70. U.S. Congress, Office of Technology Assessment, *Technology and Handicapped People* (1982) did a good job of scanning opportunities for designing and diffusing compensatory technologies for people with disabilities. On the other hand, the report made little attempt to examine how other (i.e., non-compensatory) technologies of all kinds have been designed in ways collectively constituting an environment that poses built-in challenges for people with disabilities, in effect helping establish

the unmet needs to which compensatory technologies may then be addressed.

The OTA's background paper "*Science, Technology and the Constitution*" (U.S. Congress, Office of Technology Assessment, 1987, discussed in note 68, above) was atypical among OTA studies in addressing some of the important combined social effects of multiple technologies. This study was framed in terms of a specific normative concern: How have technologies affected, and how might they affect in the future, the ethical and political principles enshrined in the U.S. Constitution? This, again, is a tangible indication that TA that is explicitly framed in normative terms may be able to make headway in evaluating social effects that emerge synergistically from the interactions among multiple technologies.

71. The first answer reflects the democratic philosophical tradition running from Rousseau (1968) through Habermas (e.g., 1982); the second reflects the distributive justice perspective of modern normative political philosophers such as John Rawls (1971) and of social justice movements. On the application of these principles to sociotechnological phenomena, see Sclove (1995b, pp. 25-44, 109-113 and 148-151). See also the sub-sections on "Social Values" and "Broader Knowledge Base," in Sect. 5, below; as well as Appendix section D, below.

72. See the sub-section titled "Non-Partisan Structure and Governance" in Sect. 6, below, including note 140.

73. Students of political philosophy will recognize this as an instance of Jean-Jacques Rousseau's insight that the "general will" is something different from the sum of particular wills: "There is often a great difference between the will of all (what all individuals want) and the general will; the general will studies only the common interest while the will of all studies private interest, and is indeed no more than the sum of individual desires" (Rousseau, 1968, Book II, chap. 3, pp. 72-73). See also Sclove (1995b, p. 218).

74. Jackson (1985, pp. 280-281).

75. See Sclove (1995b, pp. 3-9, 37-44 and 61-82).

76. Dietz and Stern, eds. (2008, p. 62). See also Appendix Section D, below, regarding pTA processes – such as Danish-style consensus conferences – that move beyond representing organized stakeholder groups by including broad and balanced samples of everyday laypeople who can collectively reflect diffuse societal interests or articulate an approximation of the overall common good.

77. Published articles promoting restoration of the OTA include Morgan et al. (2001); Wakefield (2001); Nader (2006); Kahn (2007); Mooney (2008); Epstein (2009); Holt (2009); and Fallows (2010). Grifo (2010) is an example of recent congressional testimony that supports re-opening the OTA; see also the Union of Concerned Scientists webpage titled "Restoring the Office of Technology Assessment," www.ucsusa.org/scientific_integrity/solutions/big_picture_solutions/restoring-the-ota.html (accessed 1 March 2010).

78. A partial review of congressional efforts to revive the OTA, or to otherwise re-invent a congressional TA capability, appears in Knezo (2006).

79. Will O'Neal, Congressional Science Fellow in the Office of Representative Rush Holt, e-mails to Darlene Cavalier, 16 June 2009.

80. Quoted in Jones (2004). If the argument in Sect. 1, above, that TA more than pays for itself is valid, then Congressman Kingston's economic reasoning may represent an instance of being penny-wise and pound-foolish. However, regardless of the merits of the argument, he was expressing a perspective that has demonstrated some appreciable political traction within Congress. (Note: Rep. Kingston refers to the GAO as the "General Accounting Office"; in mid-2004 Congress changed the name of the agency to the Government Accountability Office.)

81. Hill (2003, pp. 107-109); Ahearne and Blair (2003, pp. 118-125); and "Details on the National Academies Complex (2003).

82. Peha (2006, p. 24).

83. E.g., Adler et al. (2008, pp. 10-12); Chubin (2000, pp. 31-32); Morgan and. Peha (2003b, pp. 5-8); and Wagner and Stiles, Jr. (2003, p. 169).

84. Council on Public Affairs, American Society of Mechanical Engineers (2002); Adler et al., (2008, p. 22); and Ahearne and Blair (2003, p. 121).

85. Blair (2006, pp. 37-38).

86. Scientific and Technical Advice for the U.S. Congress (2006, p. 6).

87. Quoted in Adler et al. (2008, p. 9).

88. Obama (2010).

89. Morgan and Peha eds. (2003a); *Scientific and Technical Advice for the U.S. Congress* (2006); and Keiper (2004/2005).

90. Knezo (2006, pp. 4-6); Fri et al. (2003); Jones (2004); "Final Vote Results for Roll Call 359" (2004); and Committee on Appropriations, U.S. Senate (2007, pp. 42-43).

91. Richard Hung, GAO Center for Technology and Engineering, personal communications, 28 Oct. 2009 and 28 Feb. 2010; and Dr. Ana Ivelisse Aviles, GAO, conversation with David Guston, 20 Feb. 2010. GAO technology assessments completed to date include United States General Accounting Office (2004) and United States Government Accountability Office (2005) and (2006). GAO's first technology assessment included a brief discussion of the implications for civil liberties, privacy, traveler convenience and international relations of the use of biometric technologies for U.S. border security (United States General Accounting Office, 2002, pp. 115-120).

92. Dr. Tim Persons, Chief Scientist, U.S. Government Accountability Office, personal communication with Darlene Cavalier, 17 Sept. 2009.

93. Morgan, Peha and Hastings (2003, pp. 153-155).

94. Epstein (2009).

95. Chubin (2000, p. 31).

96. The Technology Assessment Act of 1972 is online at www.princeton.edu/~ota/ns20/act_f.html (accessed 3 Aug. 2009).

97. In a different context than the politics surrounding the OTA, Congress has had limited exposure to the concept of participatory TA. The 21st-Century Nanotechnology Research and Development Act of 2003 includes a provision that the development of nanotechnology under the act must consider "ethical, legal, environmental and other appropriate societal concerns," including by integrating "public input and outreach . . . by the convening of regular and ongoing public discussions, through mechanisms such as *citizens' panels, consensus conferences*, and educational events, as appropriate. . . . " This is the first time that the U.S. government was required by law to convene "regular and ongoing public discussions," via procedures such as consensus conferences, as an integral component of a federal technology development program. (The quoted legislative language is from Public Law 108-153, 2003, sect. 2(b)(10), with emphasis added.)

    One result of this public participation provision has been the funding of two subsequent U.S. consensus conferences on nanotechnology, including the National Citizens' Technology Forum on Nanotechnology and Human Enhancement, discussed in Appendix section B(ii), below. (Colleen Cordes, former Chair of the Board of The Loka Institute, e-mail to Richard Sclove and others, 19 Jan. 2004; and Patrick W. Hamlett, telephone conversations with Richard Sclove, 15 July 2009 and 30 Jan. 2010.)

98. *Scientific and Technical Advice for the U.S. Congress* (2006) and Adler et al. (2008). On the virtues of participatory technology assessment, see Sect.1, above, and Sect. 5, below.

99. Holt (2006, p. 13).

100. The unnamed member of Congress is quoted in Adler et al. (2008, p. 11, emphasis added). The Union of Concerned Scientists testimony construing TA as entailing technical analysis of science- or technology-intensive issues is by Dr. Francesca Grifo (2010, pp. 2-6).

101. Sclove (1995b, especially chaps. 1 and 2).

102. Technological dimensions of some of these transformations are discussed in Colton and Bruchey, eds. (1987).

103. This and the preceding two paragraphs are adapted from Sclove (1995b, p. 5).

104. E.g., Hackett et al., eds. (2008). See also Levidow (2007, e.g., p. 28): "In technoscientific debates distinctions are drawn between technical and non-technical aspects of an issue; such language is often used as weapons in power struggles."

105. Lars Klüver, Director, Danish Board of Technology, telephone call with Richard Sclove, 29 June 2009. See also Callon et al. (2001); Wakeford, ed. (1998); Decker and Ladikas, eds. (2004, pp. 34, 45); Burgess et al., (2007); and Klüver and Hoff (2007).

106. See the quote from Bimber (1996) in note 62, above; Decker and Ladikas, eds. (2004, pp. 1-2), quoted in the sub-section "Myths of Expert Impartiality" in Sect. 2, above); and Box 9 and note 109, below.

107. Recall Box 3, above.

108. See also Stirling (2008) and Dryzek et al. (2009).

109. The phrase "informed popular opinion" bears note. In ordinary public life, one can gather the pulse of already-informed persons (e.g., as expert TA does), but that offers little insight into the views of the public as a whole, in all its diversity. However, if by "informed popular opinion" we mean what the broader citizenry *would* think if it had a chance to develop an informed opinion, this can exist as a hypothetical

ideal, but in practical terms it is normally unknowable. On the one hand, through conventional public opinion polls or focus groups we learn relatively "*uninformed* popular" opinion. And on the other hand, through conventional interest-group politics, such as the advocacy work of organized stakeholder groups (including self-designated public-interest groups), we learn the views of "informed *non-popular*" opinion (that is, the views of knowledgeable, self-selected communities of interest). In contrast, through a process involving relatively random selection of participants, such as a consensus conference, citizens' jury (www.jefferson-center.org), deliberative opinion poll or 21st-Century Town Meeting, we can learn what lay citizens think and feel after they have had a chance to learn from a balanced group of experts and stakeholders, and then processed this new information through the fire of deliberative give-and-take and personal reflection (see also note 202, below). Representative citizen deliberation thus offers an approximation of the hypothetical "informed popular opinion," but how close and satisfactory this approximation can be in practice remains a question, depending partly upon specifics of how a particular process is organized.

110. Dietz and Stern, eds. (2008 p. 50); related observations appear on pp. 56 and 83. See also Krimsky (1984); Brown and Millelsen (1990); Fischer (2000); Kleinman, ed. (2000); and Goven (2008).

111. Pertinent in this regard is the empirical finding of Dietz and Stern, eds. (2008, on p. 76, summarizing the conclusions of chap. 3), that "on average, public participation [in environmental decision-making] is associated with better results, in terms of criteria of quality, legitimacy, capacity."

112. E.g., Grin et al. (1997); and Klüver and Hoff (2007, pp. 50-58).

113. The information in this box is drawn from Berger (1977); Gamble (1978; the quotes are from pp. 950-951); and the Organisation for Economic Cooperation and Development (1979, pp. 61-77).

114. Wood (1997, pp. 154-155).

115. Philbrick and and Barandiaran (2009, p. 344).

116. For instance, assembling the western European and U.S. national partners for the World Wide Views on Global Warming project (see Appendix section B(iii)) required only a matter of days or at most a few weeks, because both regions already include a formal (in the case of Europe) and informal (in the case of the United States) network of institutions that are experienced in conducting pTA.

117. I have found preliminary evidence that Danish-style scenario workshops *do* tend to orient participants' attention toward how technologies influence basic social and political relationships; see Sclove (1998a and 1998c).

It is also suggestive that lay participants in both the Berger Inquiry (Box 7, above) and the 2006 Boston Consensus Conference on Biomonitoring (Appendix section C(ii)) appear to have done a better job than expert analysts in identifying and addressing certain sociotechnological dynamics. It is therefore worth investigating whether attention to sociotechnological dynamics has occurred in other pTA exercises and, if so, why? Might it, for instance, again relate to my claim that laypeople are more inclined to bring their social values overtly to bear in the assessment process?

Appendix section B(iv), below, summarizes one attempt to deepen participatory analysis of technology's role in shaping basic social and political structure: a 2002 Lowell, Massachusetts, scenario workshop on urban ecology and democracy. I was involved with initiating and executing the Lowell project. I judge it important as proof-of-concept – demonstrating that it is possible to develop a pTA process that is attentive to ways in which multiple technologies can influence a community's basic social and political structure. The pTA method developed and tested at Lowell, which involved explicit use of the questions related to democratic structure shown in Table B (in Appendix section B(iv), below), was also somewhat cumbersome, but it proved workable enough that it should inspire further methodological innovation in expanding the scope of expert TA and pTA; see also Sclove (1998b).

118. See Appendix section B(iv).

119. See also Stirling (2008, especially pp. 285-286) and MacNaghten et al. (2005).

120. E.g., Noveck (2009). On collaboration as a tool for identifying efficient means to predetermined ends, Noveck writes, "With new technology, *government could articulate a problem* and then work with the public to coordinate a solution." Or "Collaboration shifts the focus to the effectiveness of decision-making and outputs. . . . Collaboration requires breaking down a problem into component parts that can be parceled out. . . . *Collaboration is a means to an end*" (2009, pp. xiii, 39, with emphasis added).

121. The concept of instrumental rationality has been analyzed most sharply and deeply by European social philosophers such as Jacques Ellul, Martin

Heidegger, Herbert Marcuse and Jürgen Habermas. See, for example, Zimmerman (1979) and Feenberg (1991, chaps. 4, 5 and 8).

122. Noveck (2009, p. 50), for example, to her credit effectively acknowledges this. The Peer to Patent program that she initiated is concerned with collaboratively informing and expediting the process of examining and issuing U.S. patents. However, she also correctly notes that "patents often do little to stimulate innovation. In many fields, broad patent protection may even lock up innovation and slow technological development." If one furthermore recognizes that not all innovation is unequivocally or preponderantly socially beneficial – a premise foundational to the concept and practice of technology assessment – then this exemplifies the problem in advancing means (e.g., efficiency in the operations of the U.S. Patent and Trademark Office) without also considering ends (e.g., whether patenting itself is unequivocally, preponderantly or optimally socially beneficial, or might be made more so – which would necessarily entail more than increased efficiency in issuing patents).

123. See, for example, Appendix section D, below.

124. See Box 6, above, and Sect. 8, below.

125. Although the analogy is inexact, there is related insight in the observation of Upton Sinclair in 1934 that "it is difficult to get a man to understand something, when his salary depends upon his not understanding it!" (Sinclair, 1994, p. 109).

126. Sect. 6 and Appendix section E, below, suggest that a new U.S expert-and-participatory TA capability should incorporate deliberative pTA methods, a collaborative and partially distributed organizational structure, while exploring other opportunities for effectively incorporating collaborative practices. Indeed, modern pTA has already begun to incorporate distributed deliberative and collaborative practices; see the National Citizens' Technology Forum and World Wide Views on Global Warming project, discussed in Appendix section B, below. Likewise, European pTA scenario workshops have always involved collaborative brainstorming among knowledgeable stakeholder representatives (albeit, to date without the additional benefits that can come when one incorporates the insights of many more knowledgeable people through open online collaboration).

127. "Measuring Chemicals in People" (2006, p. 4). For further information about the Boston Consensus Conference on Biomonitoring, see Appendix sections B(i) and C(ii), below.

128. Nelson et al. (2009, p. 498).

129. E.g., Fung (2004, especially pp. 49-50); see also Philbrick and Barandiaran (2009, pp. 344-345).

130. Goven (2003). Other useful analyses of the problem of framing include Stern and Fineberg, eds. (1996, chap. 2); Decker and Ladikas, eds. (2004, pp. 24, 38 and 71-74); Jensen (2005); Wilsdon (2005); Goven (2006); Levidow (2007); Wynne (2007); Felt et al. (2007, p. 41); Klüver and Hoff (2007, pp. 21-26 and 36-74); Stirling (2008); and O'Neill et al. (2008, pp. 12-14 and 21). See also note 44, above.

Morgan, Peha and Hastings (2003, p. 147) argue that a congressional TA agency "must avoid value judgments or offering policy prescriptions," but should instead serve Congress by "framing problems (i.e., helping members and their staff understand how to think about an issue)." However, Goven's (2003) discussion reveals that it is harmfully naïve to suppose that framing can ever be value-neutral or value-free.

131. E.g., O'Neill et al. (2008) and Goven et al. (2009, especially pp. 2-3, 38-40 and 52-59). pTA that selects demographically representative panels of laypeople normally stratifies a sample according to such criteria as age, geography, socioeconomic status, education, gender and race. Philbrick and Barandiaran (2009, p. 345) suggest that in the U.S. political context, it may also be important to ensure balance in attitudinal areas, such as political party affiliation. Some pTA practitioners prefer selecting pTA citizen representatives using the sampling methods of public opinion pollsters. See also Longstaff and Burgess (no date).

132. An early work on the evaluation of pTA is Mayer (1997). More recent treatments include Rowe and Frewer (2004) and Burgess and Chilvers (2006). Important works on evaluating the social and political roles of both expert and participatory TA include Decker and Ladikas, eds. (2004, especially chap. 2) and Klüver and Hoff (2007), which is a manual for using the online tool that is available on the www.doingforesight.org website. For a good example of evaluation in the related area of participatory environmental assessment, see Dietz and Stern, eds. (2008). Although also not specific to participatory TA, two excellent recent review articles discuss empirical evaluation of exercises in deliberative democracy: Delli Carpini et al. (2007) and Thompson (2008); see also *Public Participation in Europe* (2009, pp. 36-39). Sources such as these offer many helpful suggestions on concepts and methods that can be applied to evaluating pTA.

However, evaluation of pTA may also require adaptations to consider properly the distinctive conceptual complexity of issues that can be involved in pTA. For instance, none of the preceding works takes into account a key theoretical point developed in Sclove (1995b, especially pp. 26-27), namely, that from the standpoint of normative democratic theory, the legitimate outcomes of citizen participation are implicitly constrained by the requirement to perpetuate the necessary conditions of democracy itself. Inasmuch as technologies – individually and collectively, as well as directly and indirectly – shape and help constitute the structural conditions of democracy, it is crucial, but not sufficient, to evaluate pTA *procedurally*. Some effort must also be made to evaluate pTA's *substantive* efficacy in considering the social structural influence of the technologies being assessed. There is presumably no impartial way to evaluate the particular normative judgments that participants may make, but one can at least evaluate whether or not a pTA process has, for instance, supported lay participants in re-framing issues as they prefer and in considering technologies' potential social structural repercussions, sociotechnological dynamics, multi-technology synergisms and so on.

133. See also Guston (2003, pp. 78-79) and Decker and Ladikas, eds. (2004, pp. 29-51).

134. Guston and Sarewitz (2002); MacNaghten et al. (2005); Barben et al. (2008); Stern et al. (2009); Fisher et al. (2006); Schot and Rip (1997); Grin et al. (1997); and Decker and Ladikas, eds. (2004).

135. Table B in Appendix section B(iv), below, presents one example of a tool that could potentially support this objective. See also note 117, above; and Sclove (1998b).

136. Analysts such as MacNaghten et al. (2005) Barben et al. (2008); and Joly and Kaufmann (2008) offer important insights and suggestions for integrating expert TA and pTA into R&D processes. However, because they are inattentive to latent and tertiary structural social repercussions, sociotechnological dynamics and multi-technology synergisms, they overlook the complementary need for monitoring, evaluating and influencing downstream sociotechnological phenomena that may emerge during the production, dissemination and use of technologies. See also Wilsdon (2005) and Fisher et al. (2006, especially pp. 487, 490-492 and 494), both of which also include useful discussion of the strengths and limitations of the "stream" metaphor for understanding the temporal unfolding of technological development and possibilities for participatory engagement within it.

Barben et al. (2008, pp. 988-991) mention tantalizing instances in which science-technology-and-society (STS) humanists and social scientists have become participant-observers in technology R&D laboratories, provoking constructive, real-time social and ethical reflection and adjustments within the technological research and innovation process. They do not investigate the extent to which contemporary law governing trade secrecy and proprietary knowledge poses a barrier or challenge to direct upstream engagement and influence of this kind; see Sclove (1995b, pp. 210 and 276-277, note 42).

The practice of participatory design is salient to the challenge of integrating societal concerns into technological research and design; see, for example, the website http://cpsr.org/issues/pd/; Binder et al. (2002); and Sclove (1995b, pp. 180-196 and 207-212). However, participatory design has most often focused on participation by workers or end-users, whereas pTA takes into account wider societal perspectives, interests and concerns.

137. U.S. Congress, Office of Technology Assessment (1993, pp. 38 and 42-46); Bimber (1996, p. 66); and Wood (1997, p. 154).

138. Stern et al. (2009, p. 1). See also Fisher et al. (2006, p. 486).

139. E.g., MacNaghten et al. (2005); Barben et al. (2008); Stern et al. (2009); and Sclove (1995b, pp. 251-252, note 74).

140. Recall the sub-section titled "Limited Insight into Synergisms" in Sect. 2, above; and Box 5.

The OTA normally produced unified consensus documents. The price paid for that tidiness was a capriciously restricted normative and analytic vision, and a corresponding disservice to excluded points of view. Disservice was thus also rendered to the broader society and democratic process, which depend upon a healthy contest among competing points of view. See, for example, Sclove (1995b, pp. 222 and 281, note 88); Bereano (1997, p. 168); Fung (2004, pp. 49-50); O'Neill et al. (2008, p. 19); Stirling (2008, pp. 280-286); and Stern et al. (2009, p. 18). Decker and Ladikas, eds. (2004, p. 71) observe: "Comprehensiveness might be increased by . . . taking into consideration the viewpoints of a multitude of actors. The latter may lead to an evaluation of conflicting policy options by relevant actors that clarifies areas of consent and dissent among actors and give way to fine tuned policies with regard to different interests." Burgess et al. (2009, p. 319) write of their participatory deliberative mapping (DM) approach to options appraisal: "DM provides a rich picture of the key drivers and consequences associated with contending perspectives, often identifying important elements of common ground. Where this is the case, the results are all the more robust for being based on a process that is designed to reveal diversity, rather than engineer consensus. The aim is therefore to prove a stronger basis for subsequent decision-making, rather than to prescribe it."

In contrast, Morgan, Peha and Hastings (2003, p. 154) reject the notion of admitting multiple partisan perspectives into TA: "On particularly sensitive topics, there may be advantages to involving more than one analysis group. However, we strongly advise perserverance with the objective of striving for balance, neutrality, and completeness within every [TA] product. An alternative, more adversarial model, in which groups espouse specific ideological perspectives, would not work in the congressional setting." Their prescription is thus premised on the idea, which I have challenged throughout this report, that it is possible and desirable to strive for value-free TA analysis.

I do not mean to suggest that consensus is always a bad thing. Uncoerced consensus among a representative sample of laypeople can be illuminating (see Box 1, above; and Appendix section A, below).

141. See Hill (2003, p. 109); "Sharing Congress's Research" (2009) and the website "Open CRS: Congressional Research Reports for the People," online at http://opencrs.com (accessed 4 Aug. 2009).

142. See Hill (2003) and Ahearne and Blair (2003).

143. Re myths of expert impartiality, see Sect. 2, above. Blair (2006, pp. 37-38) – quoted in Sect. 3, above – comments on the NAS/NRC's limited ability to make assessments that involve value judgments or trade-offs. As evidence that the CRS, GAO and NAS/NRC are prone to present themselves as capable of producing "objective" analysis:

The GAO website explains that the agency provides "Congress with timely information that is *objective*, fact-based, nonpartisan, nonideological, fair and balanced. . . . We operate under strict professional standards of review and referencing; all facts and analyses in our work are thoroughly checked for accuracy." Online at www.gao.gov/about/index.html.

From the NRC website: "The reports of the National Academies are viewed as being valuable and credible because of the institution's reputation for providing independent, *objective*, and nonpartisan advice with high standards of scientific and technical quality. Checks and balances are applied at every step in the study process to protect the integrity of the reports and to maintain public confidence in them. . . . Any National Academies report (including meeting summaries, signed papers, letter reports, or other study products) must be reviewed by a diverse group of experts other than its authors before it may be released outside the institution." Online at http://sites.nationalacademies.org/NRC/PoliciesandProcedures/index.htm.

From the CRS website: "CRS employees do not discuss work undertaken for a Member [of Congress] or a [congressional] committee with another congressional office or with anyone outside the organization. . . . We maintain an outstanding reputation for *objective* and nonpartisan analysis. Our experts are vigilant in evaluating issues without bias. A multi-layered review process also helps ensure that CRS products present issues and analysis in a manner that is fair, considered and reliable." Online at www.loc.gov/crsinfo/whatscrs.html.

Emphasis added to the preceding quotes. Websites accessed 19 Sept. 2009.

144. The NAS/NRC has not shown an inclination to incorporate participation by laypeople into its study processes, although knowledgeable stakeholders are sometimes included. Nonetheless, a number of NAS/NRC studies have evaluated and recommended citizen participation in science and technology assessment and decision-making. Notable recent examples include Pearson and Young, eds. (2002, pp. 94-98, 110-111) and Dietz and Stern, eds. (2008).

145. E.g., the National Institute of Environmental Health Sciences funded the Boston consensus conference on biomonitoring that is discussed in Appendix section B(i), below.

146. Bimber (1976, pp. 7, 23-24 and 78).

147. There is an indication of this problem in the many instances in which federal agencies have been sued for failure to conduct requisite comprehensive and impartial environmental impact assessments. See, for example, Cohen and Miller (1997).

148. Morgan, Peha and Hastings (2003, p. 154).

149. E.g., Rep. Vern Ehlers (R–MI), former Chairman of the House Science Committee, and a Ph.D.

physicist), telephone call with Darlene Cavalier, 21 May 2009. Rep. Robert S. Walker, one of Rep. Ehler's predecessors as Chairman of the House Science Committee, expressed a similar perspective in 1995, during the weeks just prior to Congress's decision to de-fund the OTA; see Sclove (1995a). Nielsen et al. (2007, pp. 26-27), in a comparative study of French, Danish and Norwegian consensus conferences, report comparable but perhaps even stronger attitudes of resistance among members of the French Parliament. The political cultural context in the United States is, however, quite different from that in France. In the United States, the Congress is a powerful institution, and there has also been significant movement in the direction of greater citizen participation in governance since the 1960s, with antecedents in American populism.

150. Decker and Ladikas, eds. (2004, pp. 72-73, 75-77, 79-80, 83 and 91) and Karapiperis and Ladikas (2004).

151. E.g., Urbina (2009) and Stolberg (2009).

152. Compare Fishkin (2009). Fishkin's basic comparison of a "Congress on Your Corner" town hall with a carefully structured deliberative process is sound. But his essay fails to acknowledge the considerable cost of organizing a deliberative poll (the specific process he is discussing), and is thus misleading in implying that deliberative polls could easily substitute for dozens, or even hundreds, of local meetings. See note 202, below.

153. Center on Congress at Indiana University (2008).

154. The OTA cost data are adjusted for inflation into 2009 dollars. The NCTF cost estimate is based on e-mail and phone conversations with, and budget data provided by, Professor Patrick W. Hamlett, North Carolina State University, 10 Feb. and 15-16 July 2009; and e-mail from Professor David H. Guston, Arizona State University, 18 Aug. 2009.

155. Hamlett (2002); Hamlett et al. (2008); Luskin et al. (2006); and Davies and Gangadhran (2009).

156. Wilson and Casey (2008).

157. Data sources for Box 10: For the World Wide Views on Global Warming project: www.WWViews.org; and Bjørn Bedsted, Project Director for WWViews, Danish Board of Technology, personal communication with Richard Sclove, 2 Oct. 2009. WWViews was originally budgeted at US$5 million; the reduced budget required scaling back the geographic scope of coverage in many of the represented nations, considerable reliance on volunteer labor and diminished global media dissemination of results. Had the project been fully funded, the cost per participant would have been closer to $1,100. For European Citizens' Consultations: www.european-citizens-consultations.eu; and Richard Wilson, Involve (UK), e-mail to Richard Sclove, 11 Feb. 2009, reporting project cost as 2 million Euros. For Europe-wide deliberative polls: Luskin et al. (2008, p. 1); Isernia (2008, especially slide 20); www.europolis-project.eu; Cabrera and Cavatorto (2009); www.tomorrowseurope.eu; and Stephen Boucher, European Climate Foundation, e-mail to Richard Sclove, 10 Feb. 2009, reporting the total project cost for Tomorrow's Europe as 1.5 million Euros and for Europolis as 2.5 million Euros. For the U.S. National Citizens' Technology Forum on Nanotechnology and Human Enhancement: see the preceding text in Sect. 8; note 154, above; and Appendix section B(ii), below. For a European consensus conference: Michael Nentwich, Institute of Technology Assessment, Austrian Academy of Sciences, e-mail to Richard Sclove, 9 Feb. 2009, reporting a typical cost of 200,000 Euros per consensus conference; and Lars Klüver, personal communication with Richard Sclove, fall 1997 (Klüver cost estimates adjusted for inflation to 2009). For Meeting of Minds: Ida Andersen, Danish Board of Technology, telephone call with Richard Sclove, 11 Feb. 2009, estimating that the project cost was in the vicinity of 2 million Euros; and "European Citizens' Deliberation on Brain Science: Process Outline," online at www.meetingmindseurope.org/europe_default_site.aspx?SGREF=3278&CREF=4333. All websites accessed 10 Sept. 2009. Currency conversion: 1 Euro = US$1.45.

158. On the need to adjust participatory method depending on the context and purpose at hand, see Dietz and Stern, eds. (2008, especially chap. 7).

159. See Morgan and Peha, eds. (2003a).

160. See note 96, above.

161. U.S. universities or university programs that have experience with pTA projects include the Consortium for Science, Policy and Outcomes (CSPO) at Arizona State University; Boston University School of Public Health; Colorado School of Mines; Georgia Institute of Technology; North Carolina State University; Pomona College; the Education for Public Inquiry and International Citizenship (EPIIC) program at Tufts University; the Center for Family, Work and Community at the University of Massachusetts-Lowell; University of California-Berkeley; the Office of Sustainability Programs and Cooperative Extension at the

University of New Hampshire-Durham; and University of Wisconsin-Madison.

162. See www.nisenet.org.

163. Note 202, below, discusses a possible trade-off between the size of a participatory process – in which larger size has the potential to allow greater accuracy in representing a wider population – and quality of deliberation. The accuracy of representation becomes a more salient issue the more that a pTA process is intended to directly inform and influence policy-making. On the other hand, the original Danish consensus conferences were aimed toward informing and stimulating broad popular debate (which might, in the fullness of time, inform and influence policy-making) rather than toward directly influencing parliamentary decisions (see Box 2, above). For informing and stimulating broad popular discussion, it might thus suffice that a pTA process include a reasonably broad and diverse range of participants, while becoming of less importance to ensure that those participants represent a statistically valid random sample of a wider population (as is sought in the case of a conventional public opinion poll or a Fishkin-style deliberative poll).

It is also possible to combine relatively small-scale, face-to-face representative deliberation with open online participation. Such a complementary format maintains the high-quality deliberation and representativeness of smaller-scale dialogue with economical inclusion of large numbers of self-selected participants via online learning, deliberation and voting. See, for example, Wilson and Casey (2008).

164. Pros and cons of parliamentary versus independent TA institutions are also discussed in Decker and Ladikas, eds. (2004, pp. 18-19, 77-78 and 93-95).

165. David Rejeski, Director of the Foresight and Governance Project, Project on Emerging Nanotechnologies, and Synthetic Biology Project at the Wilson Center, e-mails to Richard Sclove, 2 and 3 Sept. 2009.

166. Wagner and Stiles (2003, p. 167).

167. Interest in establishing a participatory TA institution in the United States has begun to grow, spurred in large measure by Cavalier (2008). A Facebook group initiated by Cavalier, "Open the OTA with Citizen Input!," has more than 500 members, who have posted many ideas on how to institutionalize pTA in the United States; the group is accessible online at www.facebook.com/home.php#/group.php?gid=39385247687&ref=ts (accessed 17 Sept. 2009). The blogosphere has started taking note. See, for example, Plait (2009); Mooney (2009); Dailey (2009); and Grant (2009).

168. Topics that have been addressed by Danish consensus conferences are listed on the websites of the Loka Institute (www.loka.org/TrackingConsensus.html, accessed 24 July 2009) and of the Danish Board of Technology (www.tekno.dk/subpage.php3?article=468&toppic=kategori12&language=uk and www.tekno.dk/subpage.php3?page=artikler/udgivelser_articles_uk.php3&language=uk&toppic=17, both accessed 4 Aug. 2009).

169. In November 2008 the DBT organized four 200-person "citizens' meetings" on the future of the Danish health care system, www.tekno.dk/subpage.php3?article=1550&toppic=kategori11&language=uk (accessed 17 Sept. 2009). The DBT has not conducted a consensus conference since 2005 owing to budgetary constraints. With a reduced budget from the Parliament, DBT is more reliant on grants and external contracts for supplementary funds. Under these conditions the DBT continues to use and innovate in pTA methods, but has for several years found it too expensive to organize a consensus conference (Lars Klüver, Director, Danish Board of Technology, personal communication with Richard Sclove, 30 Sept. 2009).

170. Lars Klüver, telephone conversation with Richard Sclove, 2 Aug. 1995; and Nielsen et al. (2007, p. 14, note 3). Horst and Irwin (2010) provide additional helpful insight for understanding the meaning of consensus seeking in a specifically Danish cultural and political context. They differ, however, in treating consensus as the defining feature of the consensus conference method; in so doing they fail to take into account the DBT's own explanation for why it asks lay panelists to see if they are able to reach consensus, or the fact that the DBT acknowledges borrowing the term "consensus conference" from the U.S. National Institutes of Health (see note 25, above).

171. For information about U.S. pTA exercises other than those described in this Appendix section, see the webpage "Danish-Style, Citizen-Based Deliberative Consensus Conferences on Science and Technology Policy Worldwide," online at http://loka.org/TrackingConsensus.html; Sclove (1997); Guston (1999); *New Hampshire Just Food Citizen Panel Consensus Conference, February 7-9, 2002, Findings and Recommendations*; Hamlett (2002); Dryzek and Tucker (2008); *Report of the Madison Area Citizen Consensus Conference on Nanotechnology*, April 24, 2005; and Powell and Kleinman (2008), as well as additional information about the Madison event

on the website of the Nanotechnology Citizen Engagement Organization (e.g., at www.nanoceo.net/about, accessed 4 Aug. 2009).

Also pertinent is extensive U.S. experience with citizen participation in environmental assessment. See, for example, the National Research Council study *Public Participation in Environmental Assessment and Decision Making* (Dietz and Stern, eds., 2008). While environmental assessment and TA tend to overlap, they also differ in several ways. Environmental assessment can be more adversarial and conflictual, because it sometimes involves costly remediation of harm that has already occurred or the allocation of costs and benefits among specific, clearly identified groups. TA, on the other hand, tends to involve greater conceptual complexity, because it typically considers environmental repercussions along with many other kinds of impacts. These different challenges tend to entail corresponding differences in procedural design.

172. Nelson et al. (2009); Scammell (2007); Cole (2007); the website "Measuring Chemicals in People – What Would *You* Say?: A Boston Consensus Conference on Biomonitoring," online at www.biomonitoring06.org (accessed 17 Sept. 2009), which includes, among other things, a 16-minute video documenting the Boston consensus conference in action; and Professor Madeleine Kangsen Scammell, Boston University School of Public Health, e-mail to Richard Sclove, 19 July 2009.

173. Guston (2003, pp. 78-79) observes that pTA "mechanisms offer little chance of serving as more than brokers of analysis that has been performed by more expert actors." That is sometimes true, but the Boston Consensus Conference on Biomonitoring is one of a number of instances of exceptions to this generalization. See also Appendix section E, below.

174. E.g., Schot and Rip (1997).

175. Hamlett et al. (2008); Philbrick and Barandiaran (2009); and Professor Patrick W. Hamlett, North Caroline State University, telephone conversation with Richard Sclove, 15 July 2009.

176. Guston (Forthcoming, p. 5). The language mandating public input appears in Sect. 11 of S.1482, a bill to re-authorize the 21st-Century Nanotechnology Research and Development Act, introduced by Senator John Kerry (D–MA) and posted online at www.opencongress.org/bill/111-s1482/text (accessed 22 Aug. 2009).

177. Information about the World Wide Views on Global Warming project is available online at www.WWViews.org. Richard Sclove has served as U.S. advisor to the global secretariat of the WWViews project.

178. The information booklet that WWViews participants received in advance is available in various languages at http://teknologiraad.surfoffice.eu/1/34. The 26 September meetings summarized the same information with four short videos that are posted online with subtitles in a dozen languages at http://teknologiraad.surfoffice.eu/1/264. The questions that the citizens addressed are online at http://teknologiraad.surfoffice.eu/1/442. (Websites accessed 3 Dec. 2009.)

179. All project results appear online at www.WWViews.org. For a policy report summarizing those results from a global perspective, see Bedtsed and Klüver, eds. (2009). For a popular presentation of some of the key project results written from a U.S.-centric perspective, see Sclove (2009).

180. This paragraph reflects e-mails to Richard Sclove from the following members of the WWViews global secretariat at the Danish Board of Technology: Lars Klüver, 19 and 20 Nov. 2009; Rasmus Øjvind Nielsen, 20 Nov. 2009; and Bjørn Bedsted, 24 Nov. 2009.

181. Sclove (1999); Scott (2002); "Lowell's Future Course Charted by Community Leaders" (2002); and recollections and files of Richard Sclove, one of the initiators and organizers of the Lowell Scenario Workshop. The European Commission has encouraged dissemination of the Danish scenario workshop method widely across western Europe; see the webpage of the European Awareness Scenario Workshops, online at http://cordis.europa.eu/easw/home.html, including the events and documents archived at http://cordis.europa.eu/easw/src/events.htm (both accessed 13 Sept. 2009).

182. Table B derives from Sclove (1995b, part II, especially p. 98) and from Sclove (1999, Table 1). Dane Netherton of the University of Massachusetts-Lowell helped enormously with rewriting these questions in more user-friendly form, conceiving the idea of using illustrative examples within each question and helping prepare the examples.

183. The comparison that follows is adapted from Sclove (2000, pp. 36-37), contrasting *Consensus Conference on the Application of Knowledge Gained from Mapping the Human Genome* (1989) with U.S. Congress, Office of Technology Assessment (1988c). Former OTA staffer Dr. Daryl Chubin argues that the criticism that OTA was weak in addressing social and ethical issues might apply to OTA's physical/

security division, but not to its health and life sciences and other divisions (personal communication with Richard Sclove, 5 July 2009). Thus in comparing a Danish consensus conference with a study produced by OTA's health and life sciences division, we are considering an instance in which, according to Chubin, OTA was displaying its strongest capabilities in addressing social and ethical considerations.

184. Bimber (1996, pp. 34-35).

185. Quoted in Nielsen et al. (2007, p. 31).

186. Committee on Human Biomonitoring for Environmental Toxicants (2006); the quoted words are from p. 74, and see also pp. 8, 17, 72-75 and 182-183.

187. See the quote by Blair in Sect. 3, above, which is taken from Blair (2006, pp. 37-38).

188. "Measuring Chemicals in People" (2006, pp. 2 and 6).

189. Committee on Human Biomonitoring for Environmental Toxicants (2006, p. 70) and "Measuring Chemicals in People" (2006, p. 4).

190. Committee on Human Biomonitoring for Environmental Toxicants (2006, p. 5 and chap. 6) and "Measuring Chemicals in People" (2006, p. 5).

191. "Measuring Chemicals in People" (2006, pp. 3-4).

192. "Measuring Chemicals in People" (2006, p. 4) and Committee on Human Biomonitoring for Environmental Toxicants (2006, p. 162; see also pp. 163, 167).

193. Recall Box 3, item 3, above.

194. Committee on Human Biomonitoring for Environmental Toxicants (2006, pp. 8, 17, 72, 74-75 and 182-183).

195. This is consistent with the observations made earlier (in the sub-section on "Social Values" in Sect. 5) about lay versus expert readiness to enunciate ethical and value judgments

196. Professor Burke speaking 12:30 minutes into the video "Boston Consensus Conference on Human Biomonitoring," online at http://biomonitoring06.org (accessed 20 Sept. 2009). Astonished at how much science the lay panel had digested in a short period of time, Burke told them that "I chaired a National Academy panel that didn't do as much work in two years as you did in two months" (quoted in Cole, 2007, p. 9).

197. See also Blok (2007, p. 170) and Dryzek et al. (2009). The latter is significant because it finds similar evidence for social and ethical concerns being articulated by lay participants in pTA exercises on genetically modified foods that were organized in Canada, the United States, the United Kingdom, France, Switzerland and Australia. This supports my argument that there are structural reasons for expecting balanced groups of laypeople to outperform balanced groups of technical experts in calling attention social and ethical considerations (recall Box 3, above, and see also Appendix section D, below).

198. In their comparative study of French, Danish and Norwegian consensus conferences, Nielsen et al. (2007, pp. 31-32) found such views especially prevalent among key actors in a Norwegian consensus conference: "Norwegian interviewees spoke of lay people as . . . contributing a 'holistic' or 'genuine perspective' . . . ordinary people possess an ability to see things in their entirety."

199. On the pervasive, intricate, but little-noted ways in which technologies latently constitute and transform the basic democratic structure of a society, see Sclove (1995b).

200. Recall Boxes 3 and 5, above.

201. See Box 1, the sub-section titled "Non-Partisan Structure and Governance" in Sect. 6, and note 140, above; and Appendix section A.

202. Renn et al., eds. (1995a, especially chapters 2 and 3) discuss some of complexities involved in deciding how well participatory deliberative procedures, such as a consensus conference, can approximate the conditions of a Habermasian ideal speech situation, and so allow a semblance of Rousseau's general will to make itself known; see note 73, above; Brown (2006); and *Public Participation in Europe* (2009, pp. 8-9). A key trade-off is that achieving more complete representation of the full diversity of a national citizenry demands selection of a large lay group, which in general increases the organizing expense while impairing the quality of deliberation (see also Guston, forthcoming, pp. 2-3; and for a contrasting perspective on this trade-off, note 163, above).

21st-Century Town Meetings, a deliberative process developed by the non-profit organization AmericaSpeaks, attempt to surmount the representativeness versus deliberation-quality trade-off by assembling 500 to 5,000 people for a day, divided into computer-linked, facilitated round table discussions of 10 to 12 demographically diverse participants (O'Neill et al., 2008, p. 23; and www.AmericaSpeaks.org). This process can, however, be very expensive. For instance, "CaliforniaSpeaks," a variant of a 21st-Century Town Meeting that addressed health care reform in California included more than 3,500 participants gathered at eight locations statewide that were linked by satellite TV transmission. The one-day event cost roughly $4.5 million. Moreover, as a one-day event a 21st-Century Town Meeting doesn't allow the same depth of education – or a significant participant role in framing issues, questions and conclusions – that is possible in a process such as a consensus conference. (Cost data for CaliforniaSpeaks derived from "Fact Sheet: CaliforniaSpeaks," www.californiaspeaks.org/_data/n_0002/resources/live/factsheet.pdf; and the websites for Blue Shield of California Foundation (http://grants.blueshieldcafoundation.org/grant-center/results.cfm), The California Wellness Foundation (www.calwellness.org/assets/docs/annual_report/ar2007.pdf), The California Endowment (http://grantfinder.calendow.org/grantfinder_inter/index.cfm?fuseaction=getindividualgrant&grant_id=20071315), The Alliance Health Foundation (www.alliancehf.org/about/grantees2008.html) and The San Francisco Foundation (www.sff.org/programs/community-health/community-health-grants-2008). All websites accessed 9 Sept. 2009.)

Deliberative Polls, a deliberative process developed by Professor James Fishkin, assemble a statistically representative sample ranging from roughly 200 to 600 people (http://cdd.stanford.edu). A Deliberative Poll has some of the same procedural characteristics, strengths and drawbacks noted above regarding a 21st-Century Town Meeting. Fishkin and his colleagues have not published detailed information on the cost of organizing a national deliberative poll, but one of their recent papers does observe that "physically assembling a random sample for a weekend at a single site is both cost and labor intensive. The expenses, mounting into six, sometimes seven, figures for national samples, include transportation, hotel accommodations, meals, and honoraria for participating" (Luskin et al. 2006, p. 6). Two European deliberative polls that each incorporated roughly 350 participants from 27 nations cost, respectively, $2.2 and $3.6 million (Box 10, above). The Fishkin group has recently begun to experiment with Internet variants of a deliberative poll, in part hoping to reduce procedural costs.

203. See also "The Loss of Habitat for Citizenship," in Sclove (2004, pp. 44-45).

204. Stirling (2008) and Felt et al. (2007, p. 41); compare Decker and Ladikas, eds. (2004, p. 71) and Fisher et al. (2006, p. 493).

205. See also the sub-sections titled "Myths of Expert Impartiality" and "Unimaginative" in Sect. 2, above.

206. See Appendix section B, above.

207. See, for example, Delli Carpini et al., (2007 p. 333), although see also pp. 329-330 for two U.S. examples of citizen deliberation that did produce policy consequences; Bora and Hausendorf (2007); and Decker and Ladikas, eds. (2004, p. 72). For insight into other beneficial results of pTA besides policy impacts, see Davies et al. (2009).

208. There are further pertinent analyses and suggestions in Decker and Ladikas, eds. (2004, especially pp. 17-18, 29 and 36-85); Cruz-Castro and Sanz-Menéndez (2005, especially pp. 441-446); Dietz and Stern, eds. (2008, pp. 53, 99-100 and 228); O'Neill et al. (2008, Box 2, p. 14); Goven (2006, pp. 110-112); Wilsdon (2005); Smith and Wales (2000); Abels (2007); Renn et al., eds. (1995a, pp. 127, 130, 181-186, 317-318 and 328-329); Joly and Kaufmann (2008); Dryzek and Tucker (2008, p. 33); Philbrick and Barandiaran (2009, pp. 344-345); on the website of the European Citizens' Consultations at www.european-citizens-consultations.eu/uk/content/about-project (accessed 10 Sept. 2009); Kriplean et al. (2009), proposing use of online social-mediating technologies to develop coalitions of support for participatorily developed position papers; and Powell and Colin (2008), which gives an example in which organizers of a U.S. consensus conference in Wisconsin followed up by providing lay participants and other citizens with extensive opportunities to continue and expand their engagement and efficacy regarding nanotechnology issues, and which also proposes involving laypeople in all phases of the design and implementation of pTA.

209. E.g. Decker and Ladikas (2004); Stern et al. (2009, especially pp. 20-25); Barben et al. (2008, especially pp. 991-993); and Wilsdon (2005).

210. Both Hamlett (2002) and Luskin et al. (2006) initiated experiments with Internet-mediated citizen deliberation that they anticipated would demonstrate the superiority of face-to-face deliberation. Both authors were somewhat surprised by how well keyboard-to-keyboard deliberation worked. As reliable and inexpensive multi-person video-conferencing

becomes more available, possibilities for effective, electronically mediated deliberation may well improve. See also Davies and Gangadhran (2009).

211. See also note 173, above. Regarding framing, see also Box 9 and note 130, above. Goven (2003) and Levidow (2007) give examples where expert or organizer framings restricted lay citizens' ability to develop and incorporate their own critical reframing of an issue; Jensen (2005) and Dryzek et al. (2009) report other instances in which lay groups have been able to break out from the confines of imposed restrictive framings. But it is preferable to include a sufficiently broad and diverse array of expert and stakeholder perspectives so that the initial framing nurtures, rather than restricts, lay participants' abilities to re-frame according to their own judgments.

212. See Sclove (1982, especially p. 47). Note 44, above, gives an example of an OTA study that did benefit from involving passionate public intellectuals. Lars Klüver, Director of the Danish Board of Technology, finds the inclusion of science fiction writers and other passionately imaginative people problematic, because such people can be too enamored of their own ideas to entertain other perspectives with an open mind (telephone call with Richard Sclove, 29 June 2009). If so, a solution might be to include such people in brainstorming sessions but not in collaborative settings that are striving to produce synthesis or to articulate a common, overarching framework.

Examples of social critics of technology include Mander (1991); Glendinning (1994, Part 2); Shiva (2000); and philosophers of technology such as Borgmann (1984, especially pp. 35-78).

213. For thoughtful consideration of the potential role of science fiction within TA, see Miller and Bennett (2008).

214. For example, the open, online brainstorming procedures that have been pioneered by websites such as www.innocentive.com could potentially provide models adaptable to allow a wider range of imaginative thinking to be incorporated into TA processes. See also Rejeski (2005); Sunstein (2006); Barben et al. (2008, p. 986); Noveck (2009); and Kriplean et al. (2009). If the U.S. Army can use wiki methods to re-write field manuals, they may work for appropriate stages of TA as well (see Cohen, 2009).

215. Jensen (2005, pp. 225, 232, 233 n. 2) observes that this division of labor is founded upon a problematic dichotomization between facts and values.

216. "Expert analytic frameworks create high entry barriers against legitimate positions that cannot express themselves in terms of the dominant discourse. Claims of objectivity hide the exercise of judgment, so that normative presuppositions are not subjected to general debate. The boundary work that demarcates the space of 'objective' policy analysis is carried out by experts, so that the politics of demarcation remains locked away from public review and criticism" (Jasanoff 2003, p. 239).

217. On layperson contributions to analysis, see the subsection titled "Broader Knowledge Base" in Sect. 5, above, including Box 7. On community-based participatory research (CBPR) see, for example, http://en.wikipedia.org/wiki/Community-based_participatory_research (accessed 27 Aug. 2009). On the practical possibility of transcending the expert-analysis/lay-deliberation dichotomy, see also Webler (1998) and the concept of "nurturing lay expertise" presented in Wakeford, ed. (1998, especially Sects. 5 and 6); and Burgess et al. (2007).

CBPR has traditionally been undertaken with or by local community groups and addressed in the first instance to local problems, albeit not infrequently with an awareness of the relationship between local and translocal; see Sclove et al. (1998, pp. 70-72). In contrast, TA analysis is not ordinarily addressed to a single locale. Preparing a comprehensive TA analysis is also more time-consuming than even the substantial seven- or eight-day commitment asked of lay participants in a consensus conference. For that reason, asking a sample of laypeople to participate for any substantial period of time in a TA analysis of emerging sociotechnological issues that are not (or, at any rate, not yet) affecting their immediate interests and, in effect, on behalf of all citizens, the national interest or the broad common good would be reasonable only if they would paid a respectable sum for their service. Within the United States there are many organizations and centers – some are university based and some are independent, non-profit organizations – that have skill and experience with CBPR. For conducting a trial run with lay participation in comprehensive, translocal TA analysis, an organization such as the community-based Center for Neighborhood Technology in Chicago, which has three decades of experience with evaluating urban technological alternatives, would be a promising candidate (www.cnt.org). Stoecker (2009) offers empirical evidence that a portion of U.S. research that purports to be community based and participatory is neither.

Others who have considered the possibility of expanded layperson participation in TA analysis include Subbakrishna and Gardner (1989) and McIver and O'Donnell (2005). The former is 20 years old, and thus does not take into account recent advances in CBPR methods and practices. The latter is up to date on CPBR methods, but relies on a rather outdated cookbook model of TA analysis (a style that dates to the days of the OTA, but that the OTA itself rejected as too mechanistic and confining). Both articles also focus on involvement of potential future *end-users* of particular technologies in TA, whereas translocal TA must always consider manifold spillover effects on *non-users* as well.

218. See, for example, Segal (1982); Corn, ed. (1986); and Sclove (1995b, p. 55). Also pertinent are the insights of social and cultural historians of technology, e.g., Cowan (1983); Tarr and Dupuy, eds. (1988); Romanyshyn (1989); Sachs (1992); and Noble (1997).

219. See, for example, Bijker et al. (1987); Bijker and Law, eds., (1992); Law, ed. (1991); and MacNaghten et al. (2005). European TA has, for instance, begun to draw insights from actor-network theory; see, for example, Klüver and Hoff (2007, p. 13); and Joly and Kaufmann (2008).

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