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Public participation in science and technology decision making: trends for the future

Jill Chopyak [a,*], Peter Levesque [b]

[a] *The Loka Institute, P.O. Box 355, Amherst, MA 01004, USA*
[b] *Social Sciences and Humanities Research Council of Canada, 905 Balzac Lane, Ottawa, Ontario, Canada K4A 4E4*

Abstract

This article examines past, current, and future trends in the relationship between science, technology, and society. The evolution of current science policy in the USA is described. The paper then examines a shift in the current scientific and research environment that is calling forth new research collaborations, and a new relationship between science and society. This shift is demanding greater public participation in science and technology decision making, changing the traditional 'trust us, we're experts' science–society relationship. The paper offers several methodologies used worldwide that provide citizens with the opportunity to participate in science and technology decision-making processes. It then examines how such methodologies are affecting research and funding agencies, and argues that such efforts need to be expanded.

Keywords: Science and technology policy; Research and development; Science, technology and society; Citizen participation; Democracy; Community-based research; Consensus conferences

1. Introduction

We live in a period of extraordinary change. The past several decades have seen the rise of the Internet, increased developments within genetic engineering, and a shift from an economy based upon physical capital to one based upon knowledge, technology, and their interaction. Driving much of the scientific and technological developments worldwide since World War II, this shift is particularly pronounced

* Corresponding author. Tel: +1-413-559-5860; fax: +1-413-559-5811.
E-mail addresses: chopyak@loka.org (J. Chopyak), peterlevesque@canada.com (P. Levesque).

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in the USA. A similar shift has occurred in the framework of science and technology development and decision making. The 'social contract' between science and society that emerged in the 1950s is undergoing a major shift with considerable implications for science and technology policy worldwide.

This paper argues that a new framework for science and technology decision making is emerging that goes beyond the traditional triple helix of government–industry–university, and that this framework has the potential for finding mutually beneficial results for traditional and non-traditional players alike. The paper examines efforts to expand science and technology decision making beyond the traditional players; examines the interface between science and society in the USA, Canada, and Europe; and discusses the current and future impact such efforts have on policy-making institutions worldwide.

2. Background

The traditional' model for science and technology decision making worldwide developed largely within the USA. In the first 25 years following World War II, the USA dominated the world in scientific and technological advances [1]. Predominantly focused on defense and basic research, this model resulted in a relationship between federal governments and university-based researchers—a relationship based on an informal 'social contract' between science and society. Developed largely by Vannevar Bush in his report to US President Franklin D. Roosevelt, entitled *Science: The Endless Frontier*, the 'contract' recognizes the relationship between the federal government and universities, and suggests that scientific and technological developments be exploited for commercial use as needed [2]. The contract also established a tacit understanding that science and research would be free from government control or regulation.

Changes in the USA and increasing competitiveness from Europe and Japan in the 1970s and 1980s shifted the trend, bringing the relationship between science, technology, and industry into closer alignment. Until then, the primary role of the US government in research and development (R&D) was funding. From 1953 to 1978, the US government funded 50–60% of total R&D in the USA. Half of this was consistently spent on defense-related areas. Traditionally, this funding went to academic researchers in universities and federally sponsored research institutions, and to private and public laboratories. During this period, scientific and technological developments were controlled largely by experts employed by these institutions, who would transfer information and results to the public and commercial interests as needed.

The insular relationship between government and universities began to shift, in large part due to increased international competition, in the late 1970s and early 1980s. Combined with allegations of scientific misconduct during the same period [2], the sphere of influence around science and technology decision making opened up to include industry. Legislation aimed at fostering innovation and technology transfer from federal research agencies to industry also solidified the relationship with

industry. The Stevenson–Wydler Technology Innovation Act of 1980, the Bayh–Dole Patent and Trademark Amendments Act of 1980, and the Federal Technology Transfer Act of 1986 encouraged commercial technology transfer, and made it possible for research developed in universities to be patented for commercial use. This spurred unprecedented emphasis on industry-based research and development.

Beginning in 1978, commercial R&D funding began to supersede R&D funding from the federal government, making the market and private sector the primary drivers of scientific and technological developments in the USA. Currently, US industry R&D spending is two to three times the amount of federal spending. This trend is consistent throughout OECD countries, as is seen in Table 1. This shift—as well as the legislative incentives mentioned above—has made industry a more prominent player in R&D.

3. Changes in research and development

The transformation in funding has significantly changed R&D methodology. The successful application of knowledge is no longer simply a process question, but rather the question for researchers is how to access available resources efficiently. This shift is forcing researchers to come together across disciplines and across institutions in new and previously unforeseen ways:

> For too long, commercialization has been understood largely in terms of the application and exploitation of existing knowledge. In the new competitive regime, commercial success requires the ability to generate knowledge using resources which are not stored in-house but distributed throughout a vast, and increasingly global network…[firms] have to develop new types of links with universities, government laboratories and other firms [3]

Examples of such collaborations abound in the science and technology field. SUN Microsystems, now one of the world's leading developers of computer networking systems, was originally developed at Stanford University. In fact, the acronym SUN

Table 1
Sources of total and industry R&D performed in OECD countries, selected years

	Year (%)			
OECD total R&D financed by:	1981	1986	1991	1997
Industry	51.2	54.1	58.7	62.3
Government	45.0	42.0	35.8	31.4
Other domestic sources	2.5	2.4	3.4	3.8

is derived from Stanford University Network. In another example, Novartis, the Swiss pharmaceutical giant, recently funded the University of California at Berkeley (to the tune of US$25 million) to conduct basic research in the Department of Plant and Microbiology. In exchange for the funding, Novartis is given first right to negotiate licenses on one third of the department's discoveries, whether those discoveries were funded by Novartis or from government sources [4].

Such research collaborations are raising significant concerns about research ethics, accountability, and conflicts of interest, as many researchers are turning their research results into commercial interests for themselves and the university. This was highlighted with the 1999 death of 18-year-old Jesse Gelsinger, a gene-therapy patient at the University of Pennsylvania where questions of conflict of interest were raised during the investigation of the youth's death.

New R&D collaborations are also raising issues about the role of universities, what is meant by 'researcher' or 'expert', how knowledge is created, and who creates it. Expanded educational opportunities have had a significant impact in moving science and technology out of traditional institutions. Not only are more people educated at a graduate or postgraduate level, but highly educated researchers are choosing to work outside universities and federal research institutions. These experts are moving into commercial areas, public-interest and non-governmental organizations. The "massification of education"[3], and the movement of experts out of traditional research institutions has developed a more informed and educated citizenry. The ability to develop, create, and understand knowledge within the scientific and technological fields is no longer kept in the 'ivory tower', but is now also found in the broader community.

Increased access to education, new methods of conducting research and development, unique collaborations, and recent scares and controversies in both the USA and Europe (genetically modified foods, mad-cow and foot-and-mouth diseases) have shifted the relationship between science and society. Scientists are now being held to greater accountability by a variety of communities (both public and private), and the idea that scientists should be trusted to work in the interest of the public good—by virtue of their profession—is no longer accepted. This is causing government leaders and policy makers worldwide to find ways of effectively communicating science and technology issues to the public and to include citizens in science and technology decision-making processes.

The idea of public participation in decision making is not new. Developing out of public-interest movements during the 1960s and 1970s, participatory processes were for the most part relegated to particular areas of society. The current trend of public participation in science and technology has a new dimension and is much more widespread. "What…may be said to be new' is the thriving methodological innovation, the wide practical application and the apparently increasing interest in, and commitment to, public participation on the part of officialdom and the scientific community"[5]. New methodologies for including the public in science and technology decision making have been developed and tested worldwide. They have shown that citizen involvement results in better decisions and builds citizen and community capacity.

4. Current trends in public participation

Citizen input into science and technology decision making currently takes many forms: community-based and participatory research, the Danish 'consensus conference', participatory urban planning, and community development and planning processes that use different scenarios to determine the best course of action (scenario workshops).

4.1. Community-based research

Community-based research (CBR) is a collaborative partnership between researcher and community. Turning the traditional research model on its head, CBR is conducted by, or in participation with, the community that is affected by the problem the research attempts to address. ('Community' in this context is defined as a group of people with like-minded interests, and can expand beyond geographical boundaries.)

Practitioners who challenged conventional top-down approaches to international development pioneered CBR several decades ago. In the early 1970s, researchers—primarily in Asia and Latin America—began to question the reductionism of most research, and its inability to solve the myriad problems individuals were facing. Working with oppressed communities, researchers began to collaborate with community members in designing and implementing research projects that had *direct relevance* to their struggles.

The idea of CBR grew during the 1980s as those involved in international development grew increasingly frustrated with their inability to solve problems related to community development, education, health, and poverty. Development practitioners began to work closely with researchers and community members using participatory research methods as a way of developing effective solutions to many of the problems they were facing.

By 1997, the Fourth World Congress on Action Research in Colombia included presentations on local and international CBR projects. For example, villagers from Kenya, Cameroon, Nepal, Pakistan, Guatemala, and Colombia presented a collaborative project with researchers to strengthen community water management. The Urban University and Neighborhood Network in the USA presented a project where researchers from seven large cities in the state of Ohio, each with its own state university, linked themselves with neighborhood-based organizing and development groups in their cities.

Other participatory models developed during the 1980s and 1990s as the old social contract for science began to break down. Another possible explanation for the rise of public, non-governmental participation in research and science and technology decision making is that all communities have more problems than resources to solve them. Involving expertise or experience from universities or other sectors is a method of leveraging intellectual and financial resources perhaps not otherwise available. There are increasing numbers of success stories of how leveraging resources, knowledge, capacity, and history have resulted in mutually beneficial results for the

majority of stakeholders in a project. The Loka Institute's examination of CBR [6] determined that this method of conducting research was not only cost effective but produced positive ancillary results which were unintended but welcome. It improved quality of life in communities, transferred results of research directly into policy making and administrative procedures, and was directly responsive to citizen needs and concerns. Furthermore it changes the fundamental nature of research by converting common research subjects into active research participants.

4.1.1. Example 1: CBR in Philadelphia

Residents in the Northern section of Philadelphia, Pennsylvania (USA) participated in collecting information about lead-poisoning awareness in their neighborhood. North Philadelphia is one of the city's highest risk areas for lead poisoning, because of the lead dust produced by lead-based paint in and on the area's old and deteriorating housing. Forty-five percent of children tested in Philadelphia are estimated to suffer from some degree of exposure to lead. And because many families in the area do not have sufficient access to health care, children are being treated only on a crisis basis and miss recommended health and development screenings. Because tenant council presidents of neighborhood apartments were part of the research team, the team was able to reach a broader study sample, as well as design an effective implementation strategy that included block parties, after-school and camp programs, and cultural activities such as puppet shows and music shows that raised the awareness of neighborhood residents of the prevalence of lead in their homes. This has resulted in a 27% increase in numbers of children tested for lead and a 10% reduction in children with dangerous lead levels.

4.2. Danish Consensus Conference

In Denmark, the Danish Board of Technology has demonstrated how creating a dialog with citizens about science and technology issues has resulted in better decisions. Their consensus conference process allows citizens to make policy recommendations about specific scientific or technological developments, and those recommendations are then included in the process by which the Danish Parliament makes its decisions. The consensus conference process brings together 12–15 citizens to learn and deliberate about a complex science and technology issue. The lay panel then hears from and cross-examines a panel of experts. This information is used by the lay panel which develops a policy statement on the issue, which is presented to policy makers and the general public [7].

The impact of the consensus conference process on policy decisions differs depending on the social and political context in which it takes place. In the Danish example, the process is supported and coordinated by the Danish Board of Technology, which reports directly to the Danish Parliament. In this context, the recommendations developed by the lay panel are directly fed into the decision-making process. The first US consensus conference (or 'Citizen's Panel') took place in 1997 in Boston, MA. Coordinated by the Loka Institute and supported by private foundations and universities, the process was not officially connected to a particular

decision-making body (although there was considerable interest from both state and federal legislatures). In that context, the conference had little direct impact on policy decisions[1].

Although the policy impact of the process differs depending on the context, a common impact is the empowerment of lay citizens. The consensus conference process has consistently demonstrated that when citizens are given relevant information, they can make coherent and well-thought-out recommendations on complex science and technology issues. A participant in the US Citizen's Panel commented "We're not the kind of people you read about in history books…Here was our first chance to shape our world"[8]. Furthermore, consensus conferences draw general attention to the particular issue they are addressing, and bring the issue into public debate. For example, a month following a Canadian consensus conference on biotechnology, the national public radio began a week-long series on genetically modified foods and a flurry of press on the issue followed [7]. As can been seen from the above examples, consensus conferences have taken place worldwide[2] on topics such as gene therapy, traffic issues, telecommuting, and transportation. The ability of this process to work in a variety of political, social, and cultural contexts is largely due to its simplicity. It is also reflective of a growing development to include citizens in the process of deciding their technological future.

4.2.1. Example 2: Australian Consensus Conference on Biotechnology

During the 1980s and 1990s, biotechnology was one of the main research agendas of the Australian government. Yet, there had been little discussion on the issue within the public domain. Consumer protests in the UK began to leak over to the Australian activist community, and the Australian Consumers Association and the Australian Science Museum decided to coordinate a consensus conference on the topic to expand public debate on the issue. A range of government ministries provided funding for the conference.

Recruitment of participants was done through advertising in a random selection of locations. Through an interview process, the 14-member lay panel was selected. Results from the process were publicized extensively through the Australian Broadcasting Corporation and via the World Wide Web.

A few months following the conference, several policy initiatives were announced. Many of these were closely aligned with the recommendations of the lay panel. Most likely, the initiatives were already in discussion prior to the conference. Yet, the process gave voice to public concerns (such as regulatory oversight) and contributed towards pushing forward the decision-making process [7].

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[1] For more information about the first US Citizen's Panel, see http://www.loka.org/pages/panel.htm.

[2] For a comprehensive list of consensus conferences around the world, see http://www.loka.org/pages/worldpanels.htm.

4.3. Scenario workshops

Developed in the early 1990s, the scenario workshop process is a participatory urban planning methodology that brings together key stakeholders to discuss and evaluate the impact of multiple technological choices on a particular setting. The process is based on four scenarios that describe the day in the life of a resident 20 years from now. Each scenario describes alternative ways of solving particular problems (such as energy, water, housing, and transportation). The scenarios are designed as visions, not predictions. Stakeholders then come together for a weekend to develop their own vision of the future, using 'role play' and the four scenarios as the basis for discussion. The goal of the process is for participants to agree upon a vision and articulate a set of action plans to achieve it [9].

The scenario workshop process requires significant preparation and planning. Recruiting a diverse group of stakeholders to participate is key to the success of the process. Its potential is to bring together local government, grassroots activists, science and technology experts, and citizens to create a vision for their community. It allows all groups to see different points of view and to deliberate about the technological choices a particular locale is making. Because of its complexity, the scenario workshop process is not as widespread as the consensus conference, and its adoption has been predominately within European settings. However, the Loka Institute and the University of Massachusetts–Lowell have recently received funding from the National Science Foundation to test the process in the USA.

4.4. Other public participation opportunities

There are other ways in which the public can be involved in research, science, and technology decision making. The Precautionary Principle is an idea that has been gaining recognition over the past 10 years. In January 1998, a group of US activists and scientists gathered together to discuss the principle of precaution, and came up with the 'Wingspread Statement' on the Precautionary Principle:

> When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof…The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action [10]

The Principle itself calls for citizen participation (those potentially affected) in the decision-making process. Applying the Principle to issues such as human genetic testing, for example, would force us to examine alternatives to such testing. Increasing the range of options that such discoveries entail fosters greater innovation and creativity in the scientific process, leading to better scientific decisions.

In the USA, the Jefferson Center has designed a wide range of processes (citizen

juries, feedback panels, public participation workshops) that bring lay citizens into decision-making processes. Although their focus is not on science and technology issues exclusively, many of their models can be adapted to the science and technology realm[3].

5. Implications for future science and technology policy

The processes outlined above are increasingly allowing citizens to take an active part in science and technology decision-making processes. This trend is having an impact on science and technology policy and funding at the federal level. In Canada, for example, a range of programs and initiatives has been created and promoted which support collaborative research projects and research-related programs between citizen groups, universities, and policy-making agencies. Among the programs funding these initiatives are the Community–University Research Alliances Program [11], the Community Alliances for Health Research Program [12], the Non-profit Sector in Canada joint initiative between the Social Sciences and Humanities Research Council of Canada (SSHRC) and the Kahanoff Foundation [13], various efforts by the Rural Secretariat [14], and a diverse portfolio of programs through ministries and agencies such at Environment Canada, Natural Resources Canada, Citizenship and Immigration Canada, Status of Women Canada, and Heritage Canada.[4] Other organizations, agencies, and initiatives are attempting to map out needs, resources, and gaps in capacity for engaging in collaborative research activities. These include the Canadian Center for Philanthropy, the National Voluntary Organizations of Canada, and the National Roundtable on the Voluntary Sector. The Policy Research Initiative of the Privy Council Office, one of the four central agencies of the Canadian federal system, helps determine horizontal research priorities within the federal bureaucracy. The theme chosen for their annual national research policy conference for 2001 is 'Bringing Communities Together' [15]. This theme directly addresses the existing gaps in knowledge, personnel, and capacity to adequately deal with the myriad issues facing Canadian communities. It is also a recognition that solutions cannot be delivered exclusively by elites in institutions but must be approached and maintained as a collaborative enterprise with feedback loops to, between, and within community-based organizations (CBOs) and other stakeholders.

In the USA, proportionately fewer government initiatives, but substantially more private foundations and private civic entrepreneurship, are involved than in Canada. The Aspen Institute has developed a comprehensive range of policy programs encouraging multi-sector research including the Community Strategies Group, Democracy and Citizenship Program, Justice and Society Program, Non-profit Sector and Philanthropy Program, and the Roundtable on Comprehensive Community

[3] For more information about the Jefferson Center and their activities, see http://www.jefferson-center.org/default.htm.

[4] The complete listing of Canadian Government Departments and Agencies is available at: http://www.canada.gc.ca/depts/major/depind_e.html#S.

Initiatives [16]. National University in California has designated itself as a center for civic entrepreneurship and is encouraging faculty to become directly involved in the needs of communities.

The leading US federal agencies that fund similar-type partnerships are the US Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, and the National Institute of Environmental Health Sciences (NIEHS). The CDC maintains programs which fund collaborative CBR in epidemiology, population health, disease prevention, as well as system delivery and management [17]. Their Urban Research Centers provide substantial funding for partnerships between scientists from CDC, universities, and CBOs. This funding is focused on addressing the many social and environmental determinants of health. The NIEHS supports university–community collaborations with their Environmental Justice and Community-based Prevention and Intervention Programs.

Private foundations such as the W.K. Kellogg Foundation, the C.S. Mott Foundation, the David and Lucille Packard Foundation, and the Carnegie Corporation are also putting funds towards collaborative research and community-based decision-making processes. The Nathan Cummings Foundation recently funded the University of New Hampshire to develop a series of consensus conferences on biotechnology for the state of New Hampshire, and the National Science Foundation has also funded a scenario workshop process in Massachusetts. US funding agencies are beginning to recognize that the old model of 'trust us, we're experts' is no longer acceptable and are exploring collaborative relationships with communities.

The European Union (EU) is probably the most progressive government entity promoting public participation and addressing the interface between science and society. A recent Working Document by the European Commission comments on this issue explicitly:

> Modern science has developed on the basis of an unspoken 'contract' between science and the institutions taking responsibility for it (universities, industry, governments), on the one hand, and society and the public, on the other. New relationships are needed that fit the new mould of science, technology and society …There is a need to…create an open dialogue between researchers, industrialists, policy makers, interest groups and the public as a whole [18].

As part of this effort, the EU recently funded a project to establish an international network of science shops/community research centers—institutions and organizations that conduct CBR in the public interest. The SCIPAS (Study and Conference for Improving Public Access to Science) project brought together nine partners from the Netherlands, Denmark, Israel, South Africa, Germany, Romania, the USA, Austria, and Ireland. Funded under the EU's Fifth Framework Program, the SCIPAS project conducted research and analysis on trends in CBR/science shop activities, and established the initial framework for an international network. The project consortium sponsored a conference 'Living Knowledge: Bridging Public Access to Research', in Belgium, 25–27 January 2001, that brought together *ca* 120 interested individuals

from 20 countries. Results from research projects were presented, and discussion included resources and projects for an international network.

Mike Rogers from the European Commission's Research Directorate General summed up the project in this way: "Living Knowledge is not just about the dynamics of the most valuable asset a society produces and that it flows to society as well as to industry; it is also about the knowledge for living the kind of life society has the right to shape for itself, in the context of today's complex world.[5]

6. Conclusion

Scientific and technological developments have significant impacts on societies, communities, and individual citizens. At the same time, the research and policy environment in which scientists operate has undergone equally significant changes over the last 50 years. Policy makers are struggling to keep up with the rapid development of new technologies and the impact these technologies have. Concurrently, the decision-making framework for science and technology has dramatically shifted. Commercial interests now have a considerable interest in research and development decisions, and are the largest funders of R&D worldwide. These shifts impact the way R&D is conducted as well as the interface point between research, science, technology, and society. A well-educated and informed citizenry is calling for greater accountability for science and technology decisions.

Many of the models discussed above reflect the shift in both the decision-making sphere and the R&D environment. The idea of bringing citizens into science and technology decision-making process, however, is not yet widely accepted. Stronger efforts are needed to promote the benefits of these democratic methodologies at the local, regional, national, and international levels. Additional research on the impact of such methodologies on citizens, communities, experts, and policy-making processes is also needed at the national and international levels. Programs in public and private funding institutions must recognize that the interface between science, technology, and society is one of the most pressing issues of the 21st century.

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Jill Chopyak is the Executive Director of the Loka Institute, a national non-profit organization in Amherst, MA (USA), working to bring a community voice into research, science, and technology decision making. Her background is in international trade issues, sustainable agriculture, and international environmental policy.

Peter Levesque is the Programs Policy Officer at the Social Sciences and Humanities Research Council of Canada, where he is involved in developing programs and policies bridging all disciplines in the social sciences and humanities. He is a Board Member of the Loka Institute.