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Engaging the Public in Technology Policy

A New Role for Science Museums

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As science museums become increasingly engaged with informal education about technology, consideration of both social values and ethical controversies becomes more central to their role. While science has traditionally been represented as largely independent of these considerations, technology more visibly presents society with choices. The Museum of Science in Boston has been experimenting with a variety of public engagement approaches designed to help visitors think and talk about the societal implications of nanotechnology. These approaches are generally interactive and two-way, allowing for the collection of data about what people think in addition to simply disseminating information about technology to them. This aspect raises ethical issues in itself. What, if anything, should museums do with information about the opinions expressed?

Keywords: *science museums; public engagement models; technology and ethics; nanotechnology; informal science education*

For half a century, science and technology centers in the United States and around the world have focused on hands-on learning experiences for the public, and especially children, that are centered on exploratory learning and discovery. These processes have a close affinity to the activities and underlying purposes of science itself. Technology and engineering, however, are more about design and innovation than about exploration and discovery.

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Although many science and technology centers have included displays of technology, except for demonstrating how machines work or showing the history of a technology, a larger pedagogical framework for informal technology education has not been clear. In seeking such a framework, educators and exhibit developers at the Museum of Science have come to the conclusion that if science and technology centers find informal technology education as important to their missions as informal science education, then they must find ways to incorporate societal values and decision making into their educational offerings. In what follows, I will outline why we have come to this conclusion, explore some of the implications, describe some program models that have promise in meeting this need for informal science venues, and raise questions about future possibilities.

When the Museum of Science decided to expand its program to include technology and engineering education, along with science education, some of us worried that without a clear pedagogical framework for exhibits about technology, the museum's exhibits might devolve into commercial world fair-like displays that serve corporate promotional interests more than they serve the public good. And so we sought to develop pedagogical models for informal technology and engineering education in the museum.

Developing Themes for Informal Technology Education

As we began to develop our own models, two important activities outside the science museum community culminated with detailed reports on technological literacy that were extremely helpful to us. In April 2000, the International Technology Education Association (ITEA) published *Standards for Technological Literacy: Content for the Study of Technology*. A parallel to the National Science Education Standards, the ITEA standards outline 20 broad standards and indicate how they could play out at various grade levels. In 2002, the National Academy of Engineering (NAE) and the National Research Council published *Technically Speaking: Why All Americans Need to Know More About Technology*. These two publications defined technological literacy in closely related ways. The ITEA (2000) stated that "a technologically literate person understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes society, and in turn is shaped by society" (p. 9). The NAE defines technological literacy as "an understanding of the nature and history of technology, a basic hands-on capability related to technology, and an ability to think critically about technological development" (Pearson

& Young, 2002, p. 11). Quite apart from the helpful details of the ITEA and NAE reports, these two definitions themselves point out that good technology education should involve understanding how technology shapes and is shaped by society and should include ways of enhancing our ability to think critically about technological development.

Societal issues and critical thinking are not new to science and technology education. *Science for All Americans*, published by the American Association for the Advancement of Science (AAAS) in 1989, noted that “engineering decisions involve social and personal values as well as scientific judgments” (p. 40). And *Museums for a New Century*, published by the American Association of Museums in 1984, argued that “science museums have a public obligation to draw attention to the ethical issues raised by research developments and technological innovation” (p. 23).

Neither ethical issues nor social and personal values are typically the core content of science museum programs and exhibits. Although they are sometimes touched on, they have historically been troublesome for science museums. Minda Borun’s evaluation of the Issues Laboratory Collaborative, a project led by The Franklin Institute in the early 1990s, pointed out that “program staff are not always comfortable presenting complex issues . . . [and] questions that lack unequivocal answers” (Mintz, 1995, p. 11).

As exhibit and program developers in science museums, we have drawn on their training, which is mostly in science or in science education. When they seek advice from experts in our communities, it has mostly been from scientists and science educators. There are, of course, museums that focus on the history of science, but hands-on science centers have mostly focused on physics, perception, chemistry, biology, astronomy, and sometimes archeology, along with other similar topics. We rarely have ethicists or social scientists on our staff and rarely even consult with them. So it is not surprising that this is uncomfortable territory for us.

Building a New Model for Museum-Based Dialogue and Deliberation

In 2002, several of us at the Museum of Science attended a session at the AAAS annual conference in Boston, presented by three researchers at North Carolina State University (NCSU) who had been studying and replicating aspects of the Danish model of citizen consensus conferences. In their session, Patrick Hamlett, Steven B. Katz, and Jane Macoubrie described a process that could take from several days to a month in which

a small group of citizens were asked to make a recommendation to the government about some specific technology policy. The NCSU folks had adapted the process somewhat and were both studying the process itself and potentially using it to get input on controversial issues (Kulikowski, 2002).

We immediately thought that if we could somehow adapt the consensus conference model further, we would have a program that addresses important technological literacy goals and that would be interesting to adult participants. Furthermore, this program model takes the burden of being expert in the subject matter off of museum staff and puts it on guest speakers and the participants themselves. The staff does not have to know the “right answer” with respect to individual and societal values, as those answers come from the participants and are acknowledged to vary across a potentially wide spectrum.

The citizen consensus conferences conducted by Denmark and NCSU involved only a small number of participants (perhaps only 12 to 15), they were paid, and it took several days to complete their work. In looking for a program model for use in museums, we needed something that could play out over a few hours at most.

In our first experiment with what we now call a forum, we asked participants to imagine that they were appointed to a citizen advisory committee for their town charged with determining whether genetically modified foods should be served in their elementary schools. We assembled six expert stakeholders with very different perspectives on this issue and arranged all the other participants at six round tables. After brief introductions, the participants got to chat a bit about the question, and then the six experts distributed themselves at the six tables. The small groups of participants got to talk to the experts to understand their perspectives and to get answers to questions they had. After 10 minutes, the experts rotated, each to the next table. Over the course of an hour, each table of participants had the opportunity to question each of the expert stakeholders close up. Then they worked on formulating a consensus about the question at hand. A few of the tables actually achieved consensus opinions, but most did not. At report time, we asked tables to report on what the barriers to achieving consensus were and how they attempted to reach a decision rather than on what that decision actually was. When it was all over, some participants said that this kind of activity made a fun evening out and that they would do it again. Another asked if there was a way we could do something like this for her church group. All of this suggested to us that the program had the potential to be both satisfying and valuable.

Our second program model was more ambitious. It lasted all day and included nine discussion tables physically spread around the museum so

that we could control the level of contact with the experts that each group had. In this program, we asked participants to imagine that they had been appointed to a citizen advisory committee asked to determine what kind of power generation facility their community should build. Several experts gave presentations at the beginning with some time for questions from the whole group. Then the participants split into smaller groups. Three of the groups had access to the experts most of the day, three had only limited time, when the experts were present for a Q&A, and three of the groups had no access to the experts after the opening talks. All of the groups had printed materials, Internet access, and FAQ answers prepared by the experts on hand. This program began at 9 a.m. and ended with reports and a reception at 4 p.m. By 5 p.m., the staff was exhausted from the prep work and from running the event, but the participants did not leave. They stayed and continued talking with each other about the issues raised in their discussions. We did not want to do something as logistically complex as that again, but it was clear that the participants enjoyed doing it and felt invested in it when it was over.

The Museum of Science tried a number of other programs over subsequent years (Reich, Chin, & Kunz, 2006) but was still acting as an individual player in this kind of programming. To advance the field, we felt that multi-institutional, collaborative efforts were needed.

Building Partnerships Within the Field to Explore Dialogue and Deliberation

An opportunity arose in 2005 when the National Science Foundation (NSF) distributed a solicitation to develop a network of science museums and research centers to foster public awareness, understanding, and engagement with nanoscale science engineering and technology. The solicitation (NSF 05-543) specifically referred to issues of societal implications, ethical issues, and future decision making and suggested that science cafés and other forums would be suitable deliverables (NSF, 2005). The Nanoscale Informal Science Education Network (NISE Net) was formed in October 2005, and five science museums worked collaboratively in the first 2 years of the project to research, develop, and test program models aimed at engaging adults and teenagers with informal educational experiences that incorporate discussion, dialogue, and deliberation about societal implications of nanoscale science engineering and technology. The Museum of Life and Science in North Carolina, the Oregon Museum of Science and

Industry (OMSI), the Science Museum of Minnesota, the Exploratorium, and the Museum of Science in Boston participated.

Nanotechnology is not an immediately obvious topic for public debate, as public awareness of nanotechnology is very low and there are currently no widespread burning public issues. So it is actually an ideal topic for discussion of issues around which people do not already have strong, emotionally charged positions. David Guston and his colleagues at the Center for Nanotechnology in Society have written about a concept they call anticipatory governance: “By anticipatory governance, we mean the ability of a variety of stakeholders and the lay-public to prepare for the issues that NSE may present before those issues are manifest or reified in particular technologies” (Guston, 2007, online abstract).

Anticipatory governance provides

the capacity to 1) understand beforehand the political and operational strengths and weaknesses of (knowledge-based innovations); and 2) imagine socio-technical futures that might inspire their use. With nanotechnology, we like to think that we have a good shot at anticipatory governance because those of us concerned with its societal implications have gotten into the game both a little bit earlier than with other knowledge-based innovations and in a manner in which both we and our technical target audience have learned from recent histories of the ethical, legal, and social implications of GMOs. (Guston, 2006, ¶ 8)

Our NISE Net Forum Team ventured into developing program models with a sense that programs that involve the public in dialogue and deliberation around societal implications of innovative technologies would provide participants with interesting and engaging learning experiences and also contribute to societal well-being. We were, however, getting into an area of work about which we knew relatively little. We were fortunate to be able to learn from others who had relevant experiences.

One source of early experience was Project Decide of the European Network of Science Centers and Museums. Andrea Bandelli of Project Decide adapted “democs” materials developed by the New Economic Foundation, an “independent think and do tank” in the United Kingdom, to create a series of kits for organizing game-like, self-facilitated conversations about six controversial issues related to life sciences. When their discussion is done, participants vote, and their views can be recorded on the Project Decide Web site (www.playdecide.com). Decide kits (in 28 languages!) can be downloaded from the Web site and used freely following the guidelines of a creative commons license.

We also explored a program format employed by the National Issues Forum Institute (NIFI; www.nifi.org). National issues forums provide visitors with background information on the issue under discussion using a recorded video introduction to the topic. Both the video and booklets are used to outline three or four positions that represent prevalent public views on the issue, with arguments in support of and critical of each view. NIFI trains forum moderators to lead discussions among the participants to provide a safe environment for what may be emotionally charged issues. Discussion focuses on the strengths and weaknesses of each issue as perceived by the participants.

With these program models in mind, NISE Net developed an initial forum program that centered on what role the public should play in national nanotech policy issues, entitled *Nanotechnology: Risks, Benefits, and Who Decides*. At this early stage in exploring forum formats, we encouraged some variation in the format of programs at different sites to help us explore the range of possibilities. At our five Forum Team institutions, forum programs ranged from 2.5 to 3.5 hours long and incorporated two or three expert speakers to provide background information about nanotechnology and potential applications and to identify potential societal implications that have been identified by scientists, ethicists, regulatory experts, and others. The question posed to all participants was this:

Given the potential benefits as well as the unknown risks associated with nanotechnology, who should play the major role in shaping its future development and the government policies concerning its use?

Participants were presented with three options for consideration:

Option 1: Leave it to the experts. The public doesn't know enough science to make good policy decisions. Consumer product labeling should provide warnings to the public about nanotech products. The public needs to be educated to make consumer decisions.

Option 2: Leave it to the watchdogs. Watchdog and advocacy groups can get the knowledge and expertise to represent the public interest. Public focus should be on what's going on in their own communities—economic benefit or environmental hazard.

Option 3: This public should decide. There should be widespread programs to engage the public in dialogue with scientists and deliberation on the issues, and opportunities should be created for the public to learn about nanotechnology.

These options were not carefully surveyed and crafted positions of the type developed by NIFI, but, in consultation with several social scientists, we felt they represented perspectives that could stimulate good discussion. Staff and volunteer facilitators at tables of five to eight participants helped focus discussion on the strengths and weaknesses of the three options presented as potential answers to the question under consideration.

In some versions of this forum program, after a period of discussion participants were asked to reach consensus about which of these answers was the best choice. In other versions, participants were asked to craft their own position after consideration of the options provided. This latter option provided a more satisfactory experience for participants, as most felt that none of the options provided were particularly good answers. This allowed participants to craft various versions of a check-and-balance system that acknowledged that the scientists, the watchdogs, and the public all had different knowledge and perspectives that were important to a satisfactory solution. This result corresponds in a general sense to the Center for Nanotechnology in Society view of anticipatory governance in which both stakeholders and the lay public are involved.

Forum Team members planned on programs that would serve about 30 to 40 participants, and in our first attempt all of the program spaces at all five institutions were filled within a day or two of program announcements going out. Participants were self-selected and mostly represented adults who had visited our museums within the past 2 years. About 20% identified themselves as scientists or students working in the field. Participants reported that they gained an increased knowledge or understanding of nanotechnology (83%), that they learned about societal or environmental implications (87%), and that they learned about other participants' values in relation to the issues discussed (89%). Participants also reported that they valued learning about technology, the presentations by the experts, and discussing the issues with other participants (Reich, Bell, Kollman, & Chin, 2007).

After getting experience through this first year's work, the NISE Net Forum Team reformulated its initial sprawling set of goals for forum programs to the following.

Overarching Goal

The overarching goal is to provide experiences in which adults and teenagers from a broad range of backgrounds can engage in discussion, dialogue, and deliberation around societal implications of nanoscale science, engineering, and technology, with the intent of achieving the following:

1. Enhancing the participant's understanding of nanoscale science, technology, and engineering and its potential impact on the participants' lives, society, and the environment.
2. Strengthening the public's and scientists' acceptance of, and familiarity with, diverse points of view related to nanoscale science, engineering, and technology.
3. Engaging participants in discussions and dialogues in which they consider the positive and negative impacts of existing or potential nano-related technologies.
4. Increasing the participants' confidence in participating in public discourse about nanotechnology and/or the value they find in engaging in such activities.
5. Attracting adult audiences to science centers and engaging the existing audiences in more in-depth learning experiences.
6. Increasing informal science educators' knowledge, skills, and interests in developing and conducting programs that engage the public in discussion, dialogue, and deliberation about societal and environmental issues raised by nanotechnology and other new and emerging technologies.

The Forum Team also worked to create dissemination packets that would allow others to replicate the program models explored to date and develop new program models of their own. A key component of the dissemination packet is a forum manual, under development as I write this commentary, that includes background information for presenters; information about materials and setting up for forum programs, securing and prepping speakers, marketing the programs, pre-registration and communicating with participants, and staff needs; an outline of the forum program itself; information on facilitating discussions and how to wrap up the program; and a complete set of tools and instructions for evaluating the program.

Forum packets are available on the NISE Net Web site (<http://www.nisenet.org>).

New Issues: The Future of Deliberative Forums in Science Museums

The work of NISE Net Forum Team in the past 2 years has raised a number of issues that remain to be resolved.

What role might this kind of programming play in the future of science museums? Those of us who have been involved see great potential in providing museums with a new vital role within our communities. Not only

can science museums be places to spark the curiosity and interest of children, but they can also be places for helping adults to think about complex issues of our time and the decisions we need to make as individuals, communities, and societies. Science museums are in many ways unique in providing this service to society. They currently interact with scientists, business leaders, politicians, the press, schoolteachers, students, and the public and are a natural link among these communities. They also enjoy the trust of the public and are viewed as neutral territory. Universities have carried out and will continue to carry out public programs from time to time and conduct experiments with public deliberation, but their focus is more likely to be on research than on widespread public involvement. Active public involvement in dialogue and deliberation around societal issues associated with science and technology is closely aligned with the mission of science and technology centers and can help such organizations fulfill their mandates to act on behalf of the public good.

What should happen with the ideas and suggestions made by the public in these programs? Some members of our research and evaluation team seemed to be horrified at the thought that we might provide the results of our public forum deliberations to a governmental agency. Our audiences are not randomly selected or chosen to be representative of the range of views in our communities. Furthermore, our formal evaluation processes have been aimed at understanding how we can improve our programs, not on carefully collecting and analyzing the opinions expressed or conclusions reached in them. If taken to represent the views of the public as a whole, our data would be seriously lacking as they are highly skewed.

On the other hand, social scientists argue that the program format is most effective if policy makers are directly involved or if there is a real purpose or outcome generated through the deliberation process. Without policy makers present, participants ask how the ideas generated will be used or communicated. Should science museums seek representative audiences and collect public views and conclusions more rigorously so they can present results that are more representative? This would change the nature of the business of science museums from public science education to public opinion research, a role for which they may not be particularly well equipped.

It is possible to argue, however, that even if the audiences for forum programs are not representative of the larger public, there is still value in the ideas generated by a set of interested citizens who take the time to learn a little bit about a topic and explore with each other a range of potential views. But this only raises questions about to whom such results should be

