PUBLIC PARTICIPATION IN NANOTECHNOLOGY

Report of the National Nanotechnology Initiative Workshop
May 30–31, 2006

About the Nanoscale Science, Engineering, and Technology Subcommittee

The Nanoscale Science, Engineering, and Technology (NSET) Subcommittee is the interagency body responsible for coordinating, planning, implementing, and reviewing the National Nanotechnology Initiative (NNI). The NSET is a subcommittee of the Committee on Technology of the National Science and Technology Council (NSTC), which is one of the principal means by which the President coordinates science and technology policy across the Federal Government. The National Nanotechnology Coordination Office (NNCO) provides technical and administrative support to the NSET Subcommittee and its working groups in the preparation of multiagency planning, budget, and assessment documents, including this report. More information is available at http://www.nano.gov.

About the National Nanotechnology Initiative

The National Nanotechnology Initiative is the Federal nanotechnology R&D program established in 2000 to coordinate Federal nanotechnology research, development, and deployment. The NNI consists of the individual and cooperative nanotechnology-related activities of 25 Federal agencies that have a range of research and regulatory roles and responsibilities. The goals of the NNI are fourfold: (1) to advance a world-class nanotechnology research and development program; (2) to foster the transfer of new technologies into products for commercial and public benefit; (3) to develop and sustain educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology; and (4) to support responsible development of nanotechnology.

About this Report

This document is the report of the NNI Workshop on Public Participation in Nanotechnology held in May 2006. The workshop was sponsored by the NSET Subcommittee and the U.S. Environmental Protection Agency as part of long-range planning efforts for the NNI, guided by thoughtful concern for the opinions and benefit of the American people. The recommendations of the public participation workshop provided guidance to the NSET Subcommittee and its Nanotechnology Public Engagement and Communications (NPEC) Working Group in the development of NNI strategic plans, and they continue to serve as a reference point for ongoing public participation activities related to the NNI. Some information in the body of the report was updated through 2008; the preface includes some additional updates through early 2012; however, the main content dates from 2006.

Any opinions, findings, conclusions, or recommendations expressed in this report are those of the authors and workshop participants and do not necessarily reflect the views of the United States Government or the authors' parent institutions. This report is not a consensus document but rather is intended to reflect the diverse views, expertise, and deliberations of the workshop participants.

The report was designed, assembled, and edited by NNCO staff.

About the Cover

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Public Participation in Nanotechnology

Report of the National Nanotechnology Initiative Workshop

May 30–31, 2006
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**Affiliations listed are as of the date of the workshop*

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The NSET Subcommittee is grateful to the U.S. Environmental Protection Agency for co-sponsoring this workshop and to the International Association for Public Participation, the National Coalition for Dialogue & Deliberation, the EPA, and the NNCO for their extensive logistical support for the workshop, and to all who reviewed this document.

Most importantly, the NSET Subcommittee thanks the participants of this workshop for giving their time and considerable thought to the issues raised at the workshop.

**All affiliations listed here are as of the date of the workshop.*

Preface

This report on public participation in nanotechnology is the result of a workshop convened in May 2006 by the Nanoscale Science, Engineering, and Technology (NSET) Subcommittee of the National Science and Technology Council's Committee on Technology. This workshop was part of the NSET Subcommittee's long-range planning efforts for the National Nanotechnology Initiative (NNI), the multiagency Federal nanotechnology program. The NNI is driven by long-term goals based on broad community input. It seeks to accelerate the research, development, and deployment of nanotechnology to address national needs, to enhance our nation's economy and national security, and to improve the quality of life in the United States and around the world through coordination of funding and support of research and infrastructure development activities across the Federal Government. The NNI plays a critical role in supporting a balanced investment intended to help realize the promise of nanoscale science and engineering and promote the responsible development of nanotechnology.

The purpose of this workshop was to gather input on how to engage the public in nanotechnology-related issues. At this workshop, people with a wide range of interests, expertise, and diverse backgrounds in industry, academia, government, and non-governmental organizations came together with members of the public at large to share perspectives and explore ideas on how to engage the public in nanotechnology policy development and decision making. Their discussions raised important questions and provided thoughtful answers about the reasons to engage the public in policy-related decisions, about ethical issues related to public participation, and about ways to approach public participation for nanotechnology. This report summarizes the workshop discussions and the recommendations and challenges that workshop participants identified relative to implementing effective and inclusive public participation activities for nanotechnology.

In 2008, as part of its ongoing commitment to public engagement in the nanotechnology policymaking processes, the NSET Subcommittee chartered the Nanotechnology Public Engagement and Communications (NPEC) working group to pursue progress on this front and make recommendations about public participation and engagement activities to the subcommittee and the Federal agencies participating in the NNI. This report from the NNI Workshop on Public Participation in Nanotechnology provides invaluable insights and guidance to the NPEC Working Group and the NSET Subcommittee as they plan ongoing NNI public outreach and engagement activities. For example, based in part on the workshop recommendations, the NSET Subcommittee organized a series of stakeholder workshops in 2009 and 2010 to guide the development of the 2011 NNI Strategic Plan and the 2011 NNI Strategy for Environmental, Health, and Safety Research. The subcommittee also established a website in 2010, the NNI Portal, to obtain stakeholder comment on these strategy documents.

The 2006 NNI Workshop on Public Participation in Nanotechnology was organized to solicit stakeholder perspectives and comments that would inform NNI public participation activities under discussion for proposed NNI re-authorization legislation. Although this legislation did not become law, the thoughtful recommendations in this report remain timely and make its release appropriate now, as an archival document.

Through the NPEC Working Group and other avenues, the NSET Subcommittee is committed to improving and expanding the public's input into its activities and to fostering an open dialogue with American citizens on the subject of nanotechnology.

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EXECUTIVE SUMMARY

The National Nanotechnology Initiative (NNI) workshop "Public Participation in Nanotechnology" was the first comprehensive effort of the Nanoscale Science, Engineering, and Technology (NSET) Subcommittee of the National Science and Technology Council to discuss what constitutes productive public participation with respect to nanotechnology. Ideas generated at the workshop were intended to help shape discussions and activities undertaken by NNI agencies and the National Nanotechnology Coordination Office (NNCO) related to activities for public engagement in nanotechnology.

At the workshop, stakeholders and experts in a wide variety of fields assembled to discuss issues of public participation, including who should be involved, how to promote involvement, and how to identify educational needs in order to better engage stakeholders in dialogues, discussions, and activities about the nation's nanotechnology-related activities.

After an opening session—a "Nanotechnology Primer" on the science and applications of nanotechnology—public participation experts provided workshop participants with an overview of public participation and engagement models and best practices for communicating science to diverse audiences. They discussed framing issues and communicating risk-related information in public participation activities focused on nanotechnology and other technology areas. After each set of speakers, participants joined breakout sessions where they shared ideas and perspectives on how to address the issues raised by the speakers and on how to effectively engage the public in policy-related decision making.

Recommendations made by workshop participants to the NNI agencies and to the National Nanotechnology Coordination Office can be grouped into the following themes:

- *Scale up:* Identify possibilities for convening more public participation workshops to engage greater numbers of people and to determine the breadth of the public's existing knowledge: What is known? What needs to be known? Who is doing what?
- *Prioritize:* Identify issues on which policymakers and stakeholders should have public input.
- *"Do more now":* Initiate public participation activities using iterative, multitiered processes, and evaluate the efficacy of various engagement methods.
- *Solicit event sponsorship:* Seek public and private sponsors for public participation activities.
- *Identify "publics":* Identify a wide range of publics and stakeholders to engage in immediate, mid-term, and longer-term participation efforts.
- *Apply experience:* Learn from the research literature, formal and informal education communities, and prior public participation and engagement efforts (e.g., the UK's NanoJury and NanoDialogues experiences).
- *Coordinate with educational activities:* Develop public engagement activities that are complementary to existing science education curricula.
- *Do research:* Identify public participation research needs to develop best practices for nanotechnology and other emerging technologies.
- *Distribute guidelines:* Provide guidelines to agencies, departments, and other groups about public participation approaches.
- *Develop materials for public participation events:* Identify what information should be targeted for inclusion in nanotechnology-related public participation activities, and where gaps exist, develop science-supported, plain-language materials for use in public participation and engagement activities.

- *Improve risk communication:* Create theory-based and research-supported guidance for risk/benefit communications.
- *Address structural challenges:* Examine and address issues related to funding, sponsorship, and channels for meaningful input.
- *Improve public education:* Explore ways of increasing nanotechnology awareness and stakeholder education.
- *Include program evaluation:* Identify and apply public participation outputs and metrics to evaluate public participation activities.

1. OVERVIEW

For several decades, public participation and engagement activities have experienced significant support from local, scientific, and policymaking communities, and from governmental and non-governmental organizations. In some circumstances, public participation has been incorporated into decision-making structures in the United States, Canada, and Europe. The Federal agencies comprising the National Nanotechnology Initiative (NNI) also recognize that stakeholder contributions are valuable for effective decision making.

Public engagement in policy-related matters serves the public good in that it actively supports democratic participation. When inclusive of wide-ranging segments of society, public participation balances special interests in influencing decisions. Public engagement also can lead to better decision making, because it fosters greater transparency and legitimacy when both supportive and critical points are raised and issues are deliberated broadly.

NNI PUBLIC PARTICIPATION ACTIVITIES

The NNI is a voluntary U.S. Government interagency, crosscutting program initiated in 2000 that coordinates Federal nanoscale research and development activities and related efforts. Under the leadership of the Nanoscale Science, Engineering, and Technology (NSET) Subcommittee of the National Science and Technology Council's Committee on Technology, the aims of the NNI are to accelerate the discovery and responsible development and deployment of nanometer-scale science, engineering, and technology. Currently the NNI involves the nanotechnology-related activities of 25 Federal agencies, 15 of which had budgets for nanotechnology research and development (R&D) for fiscal year 2010.[1]

Some NNI agencies have sponsored public participation activities at regional levels and in local communities where people live, work, and go to school. Several university and national laboratory communities have held workshops, consensus conferences, and other dialogues on issues related to nanotechnology and society.

NNI agencies such as the U.S. Department of Agriculture's Cooperative State Research, Education, and Extension Service (USDA/CSREES[2]) and the National Institutes of Health National Cancer Institute (NIH/NCI) fund research and activities for public outreach and engagement within or in addition to their extramural nanoscience-related research programs. The National Science Foundation (NSF) has supported public engagement activities for nanotechnology (and other science R&D) through various means, including a network of science museums and centers that identify best practices for educating and engaging public audiences about nanotechnology; the Earth & Sky broadcasts and podcasts by public radio stations (http://www.earthsky.org/); the Internet- based ScienCentral science education content producers (http://www.sciencentral.com/); the Public Broadcasting System's Nova programs (http://www.pbs.org/wgbh/nova/); and various traveling exhibits, including NanoExpress, a mobile functional nanotechnology laboratory in a van retrofitted in 2006 with advanced instrumentation (http://www.nnin.org/nnin_howard.html).

Regulatory agencies also are holding public meetings to collect broad community input on regulatory matters related to nanotechnology. The Environmental Protection Agency (EPA) has held several public meetings to gather input for its regulatory processes (for examples, see http://epa.gov/ncer/nano/publications and http://www.epa.gov/osa/nanotech.htm). The Food and Drug Administration (FDA) also has held public input activities (see http://www.fda.gov/ScienceResearch/SpecialTopics/Nanotechnology/), including public

[1] *NNI Supplement to the President's FY 2012 Budget* (Washington, DC: NSET/NSTC, 2011; http://www.nano.gov/publications-resources).

[2] Reorganized in 2008 as the National Institute of Food and Agriculture (NIFA).

meetings in October 2006 and September 2008 and solicitation of public comment on its *Nanotechnology Task Force Report 2007*, to help FDA further its understanding of developments in the use of nanomaterials in FDA-regulated products and assist the agency in implementing recommendations included in the Nanotechnology Task Force Report relating to the development of agency guidances.

Through the National Nanotechnology Coordination Office (NNCO), the NSET Subcommittee has sponsored public meetings for input on research needs and priorities related to the environment, health, and safety aspects of engineered nanoscale materials (for example, see links at http://www.nano.gov/you/environmental-health-safety). These meetings have been attended by representatives of legal, scientific, civil, industry, and government organizations, and by members of the general public. The NSET Subcommittee's focused public participation activities have included co-sponsoring an international workshop on nanotechnology public outreach in May 2007 (http://www.certh.gr/C3B79BE6.el.aspx) and chartering its Nanotechnology Public Engagement and Communications (NPEC) Working Group in early 2008 (http://www.nano.gov/npec). The Subcommittee charged the NPEC Working Group with coordinating NNI public engagement activities. The NPEC Working Group's public outreach and engagement activities have included organizing a risk-communication, train-the-trainer event in the fall of 2008.

In all, public participation in nanotechnology policymaking and other activities is of significant and growing interest in the endeavors of the U.S. National Nanotechnology Initiative. Through the efforts of the NPEC Working Group, the NSET Subcommittee and the NNI member agencies are working to actively improve and expand citizens' engagement in Federal nanotechnology undertakings.

WORKSHOP STRUCTURE AND EMERGING THEMES

The NNI Public Participation in Nanotechnology workshop took place on May 30–31, 2006, in Arlington, Virginia. This workshop was open to the general public and announced in the Federal Register and on the NNI website (http://www.nano.gov). In addition, workshop

Terminology Used in this Report

The terms "public participation," and "public engagement" are used interchangeably in this document to refer to any planned conversation among diverse publics where opinions and values are recorded for the purpose of using those opinions and values as inputs to decision-making processes. Among these conversations are dialogues (discussions) and deliberations (discussions with intended outcomes of consensus recommendations). Polls or surveys are not included in this definition.

The term "public" is commonly defined as "pertaining to the community as a whole" (*Random House Unabridged Dictionary*, Random House, Inc., 2006). When "public" is used in public participation activities, the term refers to activities in which anyone may participate, within certain limitations such as space restrictions, but not necessarily representative of a particular community or organization. Individuals involved in public participation and engagement activities are often motivated by knowledge or interest in a subject and are already connected to the notification process.

Beyond being open to everyone, it is generally assumed that quality public participation occurs when deliberate efforts are made to recruit participants who come from varied stakeholder communities and represent diverse points of view. In order to attain a diversity of views, public participation organizers need to involve "publics," or representatives of all demographic, social, or interest groups—formal, informal, or inferred such as consumers—that might have a stake in a policy-related issue.

Definitions of specific models of public engagement activities referred to in this document are based on the public participation spectrum defined by the International Association for Public Participation (IAP2), a global organization of public participation practitioners and academics conducting research in the field. The IAP2 "Spectrum of Public Participation" involves public participation activities designed to inform participants, consult or engage participants in problem solving, involve or listen to them, collaborate with participants in developing agreements, and/or empower participants to make decisions themselves (see http://www.iap2.org/associations/4748/files/IAP2%20Spectrum_vertical.pdf).

Thus, the terms "public participation" and "public engagement" broadly refer to multiple models and potential outcomes rather than to a single model (for example, a public meeting) or to a preconceived outcome.

invitations were extended to about 200 people, some identified by their affiliation with groups representing specific interests and expertise, and some unaffiliated. Approximately 175 people attended the workshop, coming from non-governmental organizations, government, industry, media, and academia, or as interested citizens. The workshop was co-sponsored by the NSET Subcommittee and the EPA; it was planned by the NNCO in cooperation with the International Association for Public Participation (IAP2) and the National Coalition for Dialogue & Deliberation (NCDD).

The objectives of the workshop were to identify what constitutes productive public participation related to nanotechnology and to gain stakeholders' perspectives on

- Their interest in nanotechnology as a topic for public participation
- Appropriate roles for government in sponsoring public participation activities
- Best practices for engaging the public on the subject of nanotechnology, framing issues, communicating risk-related information, and designing informational materials

The workshop organizers also posed questions to experts and participants about how to effectively design public participation and engagement activities that would foster meaningful public input. Because workshop stakeholders, organizers, experts, and participants had varying interests and levels of expertise, organizers of this workshop intentionally posed broad and exploratory questions rather than deliberative or consensus-building questions.

The key questions that the workshop participants addressed were these:

1. What key outcomes are sought through public participation in nanotechnology?
2. What are the appropriate roles for the public in nanotechnology policymaking and decision making?
3. Which decision-making processes relevant to nanotechnology issues should include public input?
4. Who should be sponsoring public participation? Who should be listening, and how can people be encouraged to listen?
5. Should nanotechnology be considered by itself or combined with other emerging technologies in a broader societal conversation?
6. What does the public need to know about nanotechnology in order to meaningfully participate? To what extent should education be a component of public participation?
7. Is promoting open dialogue on nanotechnology enough? What types of processes and activities for public input on nanotechnology make sense?
8. Who are the "unengaged"? How can the unengaged become engaged? How can agencies move beyond traditional special interests to truly engage broad segments of the public? To what extent should they try?

The discussions were varied and lively. Despite the breadth of each discussion topic, common themes emerged from workshop discussions. Some recurring general themes that emerged include the following (in no particular order):

- Government and industry need public input.
- Public participation is appropriate for the development of nanotechnology applications and for addressing potential societal impacts.
- Models exist for effective public participation.
- It is important to broaden public discussions because products enabled by nanotechnology are already on the market and others are currently being developed.
- When policy discussions occur, it is important to solicit a wide spectrum of inputs from people with diverse interests.
- There is no one "public"; rather, there are many publics.
- Engaging everyone is not a realistic goal. Many people will choose not to be involved, even when opportunities are available. The success of public participation activities are dependent upon citizen interest and voluntary involvement.
- Citizens are more likely to participate in public discussions when they see personal relevance.
- Public participation activities should be planned with other and larger-scale communication efforts.

- Public discussions should be focused, well-defined, and organized around specific target audiences and the experts available to participate.
- Clear communications channels from workshop participants and experts to decision makers should be defined.
- Transparency in the public participation processes is critical.
- Disinterested third parties should sponsor or co-sponsor public participation activities to better establish public trust in the process.
- Public participation activities should be held in "neutral" locations and designed to ensure that participants feel that the atmosphere for discussion is impartial.
- Facilitators should be unbiased.
- Education is an important part of public participation, but science literacy is not a prerequisite for public participation.
- Educational efforts and engagement activities should not be designed for perception management or public relations reasons.
- Public participation outcomes related to public policy should be disseminated to people who are involved in the relevant decision-making processes.
- There is a need to develop and disseminate best practices for public participation in activities related to nanotechnology and other emerging technologies.
- Participants are not always well informed about the science of nanotechnology; nevertheless, it is possible and important to educate them and to elicit their perspectives regarding nanotechnology research and development.
- Public participation activities should be funded at adequate levels by the government, academia, and industry.

2. SPEAKER SESSIONS

PUBLIC PARTICIPATION: AN INTRODUCTION

Douglas Sarno of The Perspectives Group and Carolyn Lukensmeyer of AmericaSpeaks began the workshop by providing background on the current state of public participation.

Based on personal experiences as a government environmental engineer, Sarno shared his observations about the need for and value of public input for better-quality agency decisions. He felt that well-designed projects have gone unimplemented because of public opposition at late stages of project development—opposition that could have been avoided had public input been sought and public concerns addressed early in the project design. He also noted that unnecessary planning costs and efforts could possibly have been avoided.

Carolyn Lukensmeyer called for greater public participation as a step toward revitalizing democracy. She noted that this can be accomplished through anticipating the needs and desires of the citizenry to have input into decision-making processes. She suggested that the benefits of public participation include the following:

- Reducing conflict and identifying common-ground positions
- Creating constituencies and momentum for political action
- Improving outcomes by taking into account public wisdom and the perspectives of those most directly impacted
- Educating the public
- Increasing trust in decision makers

Lukensmeyer said that public participation practitioners, as members of a relatively young field, often engage local communities in the United States in discussions of common problems. She noted that, in contrast, large national dialogues are rare but have been held in both the United States and Europe. Public participation practitioners have formed professional associations, including the International Association for Public Participation (IAP2) and the National Coalition for Dialogue & Deliberation (NCDD), both of which contributed logistical and facilitator support to this workshop. She suggested that as the number of published case studies increases, these collective experiences can contribute to the development of best practices for public participation activities related to the development of nanotechnology and other emerging technologies.

Sarno and Lukensmeyer offered lists of the characteristics of effective public participation activities, as well as cautionary advice.

Sarno stressed:

- Setting clear goals and communicating realistic expectations during the planning and implementation processes
- Commitment to public participation and follow-through on that commitment
- Purposeful timing that engages the public when and where it matters
- Planning as a process, not an event
- Inclusion of all publics
- Communication through shared learning, relationship building, and interactive dialogues
- Evaluation of the public engagement process
- Dissemination of information to appropriate audiences about what has been achieved

Sarno also identified problem areas that organizers face when planning public participation activities:

- Lack of commitment
- Use of a "checklist" approach (i.e., providing opportunities for public input without intending to use the information)

- Lack of integration with decision making
- Poor timing (holding public participation activities after decisions have been made)
- Limited range of perspectives and groups engaged
- One-sided or skewed perspectives
- Inadequate feedback

Lukensmeyer emphasized:

- Diversity and inclusion
- Informed participation
- Neutral facilitation
- Values-based deliberation
- Transparent links to decision making

Following these introductory comments on public participation was a series of presentations on ethical dimensions of public dialogue, risk communication, and specific experiences with public participation models. Workshop speakers made their presentations within three separate panels organized around three main topic areas. Each panel's presentations were followed by six breakout sessions whose members addressed the panel's topic, as shown in Table 2.1. Subordinate questions within these topics are listed on the first page of Chapter 3.

Table 2.1. Topic Areas Addressed by Speakers and Breakout Groups

Speakers' Topic Areas

1. Why participation?
2. Planning for public participation
3. Engaging the public in science & technology
   - Participation in action (presentations)
   - Participation in action (panel discussion)

Breakout Groups & Topics

A. What outcomes should be sought?

B. How should public participation in nanotechnology be approached?

C. How should public participation in nanotechnology be conducted?

ABSTRACTS SUBMITTED BY PRESENTERS[1]

Carl Batt, PhD, Cornell University

A Nanotechnology Primer

Nanotechnology offers outstanding promise to revolutionize a vast array of materials, components, and devices; it will simply impact the way we do many things. As defined, nanotechnology involves the deliberate manipulation of matter at size scales of less than 100 nanometers with the anticipated benefit of realizing unique physical properties and capabilities at these dimensions.

The challenges are not only the significant technical hurdles of implementing the technology in a manner that is practical, but also articulating the impact of the field on the lives of everyday people. Nanotechnology will impact, for example, biomedical research, analytical chemistry, and the manufacturing of everything from clothing to the most sophisticated computers. It will help to build the interface between a number of fields, including engineering, chemistry, physics, and the life sciences. The world that is too small to see can be fascinating but can also instill fear. For example, many people have relatively unfounded fears of germs; this fear of things too small to see, when extended to include things that are man-made, enhances the challenge of communication. The balance between promoting the promise of nanoscale science and engineering and keeping it within the realm of reality is important. It will demand new and more dedicated approaches to informing the general population and finding novel ways to increase science literacy in the area of nanotechnology.

Panel 1. Why Participation?

(Prior to Breakout Session A)

Carolyn Lukensmeyer, PhD, AmericaSpeaks

Why Do Public Participation?

This presentation addresses two questions: (1) *why engage the public in policy-related decisions?* and (2) *what are the elements of good public engagement?*

The fundamental premise of public engagement is that the best public policy is an integration of expert knowledge and the collective wisdom of ordinary people. Due to the current political, cultural, and media environment, we are challenged in finding authentic voices of the people. There is no one public, but rather, many different interests are represented in a diverse population. Engaging a diverse public is important because it reduces conflict, identifies

[1] Affiliations listed here are as of the date of the workshop.

common-ground positions, creates constituencies and momentum for political action, improves outcomes by taking into account public perspectives of those most directly impacted, increases trust in decision makers, and educates the public.

Effective public engagement involves diversity and inclusion, informed participation (people are given materials or other instruction to educate them on a subject), neutral facilitation, values-based deliberation, and a transparent link to decision making. In order to choose the appropriate model for public engagement, critical questions that need to be considered include the stage of the policy development, when the engagement activity is planned in the political process, what is the state of the science, and what is the level of the public's knowledge.

Public engagement in policy issues is increasing in frequency as government agencies and state and local governments create engagement forums. Technology such as the Internet, video teleconferencing, and groupware are facilitating this progress. Congress has mandated public engagement for nanotechnology and healthcare issues.

David Guston, PhD, Arizona State University

What Do We Want to Learn from Public Participation in Nanotechnology?

What challenges and issues face society in the development and implementation of nanotechnology? What meaningful outcomes should we seek when engaging the public? There are practical reasons for getting public input on policy issues: public input can help policymakers achieve better outcomes from their decisions. The public has valuable insights to offer these discussions; further, consumers are instrumental in and have power with respect to technology adoption; in addition, the citizenry has symbolic power in a democracy by legitimizing decision making through its participation. Normative reasons for public input include more than outcomes. Science and technology are a part of society and are legitimate subjects for public input. For example, decisions in science and technology embody broad values relating to priorities, risks, and equities or inequities; public input helps scientists fulfill responsibilities to society for desired outcomes. But public participation is not a silver bullet; it is a means to better outcomes, not predictive of outcomes or policy decisions.

Public participation can substantively impact decisions regarding policy for regulation. Public participation can also influence general thinking about content and about procedural and political issues of developing public policy for technologies. Public participation can also train knowledgeable personnel with regard to public expectations and values and with regard to substantive and procedural matters related to technology decisions.

Public participation also provides lay knowledge to citizens about substance and process regarding nanotechnology policy, and information about potential benefits and harms related to nanotechnology and about consumer roles and interests in product development.

There are significant design challenges for public participation to ensure productive engagement and valuable information for policymakers.

Rosalyn Berne, PhD, University of Virginia

The Ethical Dimensions of Public Dialogue in Nanotechnology

Whenever a new technology such as nanotechnology emerges with the potential to reshape and impact society, public narratives emerge simultaneously that establish the meaning, significance, and even the moral boundaries of that technology. Narrative, the use of language-based stories, is a basic tool that human beings have to make sense of what we perceive and experience, and to invest those with meaning. It provides access to otherwise unarticulated hopes, fears, expectations, and assumptions regarding our relationships to our bodies, to one another, and to the physical world we inhabit.

There are myriad forces at work inside the development of nanotechnology. One of those forces is the competition to shape the course of human events. Public narratives have an important role in defining and exploring the meaning and significance of nanotechnology and in constructing an ethical framework for nanotechnology's evolution and development. The narratives of individual research scientists and engineers need to be included in the public discourse, not simply as the voices of professional experts, but as interested citizens with their own stories to tell. The successful building of public trust and understanding requires the inclusion of individual laboratory researchers as persons, contributing their own understandings, ideas, beliefs, and perspectives about the nanotechnology initiative to the wider, public discourse.

Although individual nanotechnology researchers can be introspective and thoughtful about their own research, their participation in public discourse is rare. Few scientists are speaking and writing to non-expert audiences about nanotechnology, particularly about its societal dimensions and ethical implications. As a group, research scientists and engineers have had a long history as agents of social awareness. They have spoken out in public against technology policies and government practices when reasonable moral limits were crossed. However, so far, they generally have been publicly uninvolved in the ethical guidance of nanotechnology development, seeming to relinquish that role to the public spokespersons of the science community by abstaining from expressing their own voices. Yet these very voices of the lesser known, behind-the-scenes, individual researchers—speaking not for or from "the community of science" or on behalf of their sponsors, but for themselves—are those that are especially needed in the narrative processes of public engagement for understanding.

David Ropeik, MA, Harvard School of Public Health
(Luncheon Speaker, Day 1)

Nanotechnology and Risk Perception

The industrial/technological/information age has, by many basic metrics—such as increased lifespan, reduced infant mortality, and all-but-complete eradication of many major diseases—made this a much safer and healthier world for billions of people. But many of the goods and services of our modern age, and indeed the very pace of progress, also bring new hazards, forcing societies to choose between risks and benefits. Often we face such tradeoffs before our knowledge about new products and processes is complete. In the absence of complete information, humans use affective and intuitive risk perception heuristics—mental shortcuts—to guide their choices. Simply put, we use both facts and fears to decide. Risk perception will play a fundamental role as nanotechnology moves, or attempts to move, from the research lab into the marketplace. Even as the natural sciences are beginning to investigate the physical risks of nanotechnologies, we must understand the psychological risk perception characteristics of this powerful new way of controlling matter if thoughtful and wise tradeoffs and choices are to be made that maximize nanotechnology's potential while minimizing risks to human and environmental health.

Panel 2. Planning for Public Participation

(Prior to Breakout Session B)

Douglas Sarno, MBA, The Perspectives Group

Best Practices and Processes for Public Participation

How can successful public participation be planned, to include selecting the right level of participation, designing inclusive participation, and matching techniques appropriately to objectives? Public participation is any process that seeks to understand public values and use input from diverse publics in a planned effort to improve decision making. Public participation must provide a genuine opportunity to influence; it should not have "buy-in" from the public as its goal.

The "seven sins of public participation" are (1) a lack of commitment and/or a negative attitude; (2) a checklist approach (providing opportunity for public input without the intent to use it); (3) a late start (after decisions are made); (4) a lack of integration with decision making; (5) limited engagement of perspectives; (6) one-sided information; and (7) inadequate feedback.

The seven best practices of public participation are to (1) clarify intent (select the right level, set clear goals, make an explicit promise); (2) commit (integrate public participation into decision making, seek input you intend to use, deliver what you promise, demonstrate what you deliver); (3) engage the public where it matters—upstream: values–principles–policies–action (start at the beginning, focus on values first, ask the right questions); (4) plan (public participation is a process, not an event; integrate it into decision making, match tools to objectives); (5) be inclusive (there is no one "public," seek out all important voices, resist talking only to the "usual suspects"); (6) communicate on a human scale (shared learning, relationship building, dialogue); and (7) evaluate (seek continuous feedback, know your "goodwill" balance, adjust to meet public needs).

Barbara Herr Harthorn, PhD, University of California, Santa Barbara

How Do We Identify the Publics to be Engaged in Nanotechnology?

Current low awareness among the U.S. publics of nanotechnology's meanings poses both challenging problems and incredible opportunities for the design and implementation of public participation programs. Because awareness is low, we can't simply ask people what

they think about nanotechnologies—a new approach is needed. Similarly, identifying who will be most interested and most concerned about emerging nanotechnologies is more a matter of prediction than knowledge; we simply do not yet know who will come forward, through what social or political processes, and with what aims and intentions, particularly from what we might call the "general public." Longitudinal research that will follow the course of the publics' developing understandings and participation are essential for understanding reception related to nanotechnologies.

The low level of public awareness raises questions about the reasons to engage the public at this time. Current and past social science research with these and other technologies inform our approach to public participation. We also draw heavily on analogies from other technologies and their publics. There is recognition and acceptance of the need to do public participation differently with these new technologies, in particular with aims of facilitating two-way communication between science and society. Past efforts have failed primarily because of the lack of sufficient engagement or the initiation of engagement at a point too far down the developmental path, when the publics' priorities and/or concerns cannot alter the course of technology development or promulgation in society.

There will certainly be diverse communities of stakeholders with distinct judgments on issues, concerns, practices, and acceptability. The publics for nanotechnology are emerging in different ways and are being tracked through different research methods. Our research on Internet networks indicates that among nonprofit non-governmental organizations, environmental groups are leading the global uptake of nanotechnology-related issues. The different perceptions or beliefs that people have about risks are important predictors of behavior and are the reasons why we are focusing on them. Spatial analytical tools will provide important insight into these demographic divides. Factors known to produce these divisions include histories of exposures and ill health, race, class, gender, and education, among others. Understanding such differences is critical to successful democratic engagement.

One paradoxical challenge to enhanced public participation in debates on nanotechnologies is that people with low (attenuated) perceptions of risk are particularly unlikely to pursue additional knowledge or self-protection, whereas those with elevated senses of risk and vulnerability may demand higher levels of reassurance and resources. Complicating this scenario, nanotechnologies themselves are multiple in form and application. Within this context, in the absence of a large-scale risk event that generalizes to "nanotechnology" writ large, there are likely to be different publics for the very different technologies.

Just as the publics are multiple, so are the experts, who may have significant differences by discipline, research focus, work context, and other factors. Understanding these distinctions will be important for public participation, because expert involvement will shape kinds and types of experiences and outcomes. Scientists' judgments about the publics will likely facilitate or impede engagement on their side.

Dietram Scheufele, PhD, University of Wisconsin-Madison

What Do We Know About Public Opinion?

Public engagement in science and scientific decision making takes different forms that do not work equally well in all settings and for all sub-publics. There are distinguishable differences between public engagement with specific groups in citizen forums and town hall meetings, and public outreach to large cross-sections of the populations through informational campaigns and mass media.

Most engagement efforts for nanotechnology are aimed at informing members of the public, engaging them in debate, and building literacy. All these are important but have not had a broad impact. In fact, most research shows that engagement efforts such as town hall meetings or science cafés reach only a small number of highly interested and often already informed citizens, while the rest of the citizens receive their information through other means, including the Internet, science publications, science coverage in newspapers and magazines, and television news and entertainment media (the largest percentage by far). So how do uninformed and uninvolved publics form attitudes about nanotechnology?

In the absence of factual information, they form attitudes by relying on shortcuts or heuristics. In fact, many democratic scholars argue that it is not necessary for most people to develop in-depth understanding of issues

to form attitudes using heuristics such as predispositions, opinion climates, or media frames. Frames have little to do with information, but rather influence which schema is activated in people's thinking when they process information. The same information, framed differently, can evoke very different interpretive schema in people's minds. Frames for nanotechnology largely have been positive and based on the economic and scientific potential of nanotechnology. Coverage has started to change, becoming more negative, based on parallels to other dangerous technologies and speculative predictions. Research by Lewenstein and Scheufele (2005)[1] has demonstrated that frames, rather than literacy, currently influence nanotechnology-related attitudes. Further, the public's view on issues such as stem cell research or nanotechnology are often shaped by religious beliefs, levels of trust in regulatory bodies, and other factors that have little to do with information about the specific technology that is being discussed.

An agenda for successful public outreach should not focus on promoting pro-science views among the general public or simply on improving science literacy. To be effective, public outreach must base communication with all stakeholders (scientists, citizens, policymakers, etc.) on systematic research of different publics and their informational needs and concerns. Currently, public debate about many scientific issues is dominated by interest groups and other partisan players, and scientific views are not heard. As a result, scientists need to learn to effectively address issues outside the realm of science when communicating with the public, and to make the ethical, legal, and societal implications (ELSI) issues newsworthy in a nonpartisan way. A broad debate about nanotechnology—including different sub-publics—should take place. The question is whether and if scientists will have a prominent voice in this debate.

Panel 3-1. Engaging the Public in Science & Technology (Prior to Breakout Session C)

Rob Semper, PhD, The Exploratorium

Engaging the Public in Science and Technology

Engaging the public in science and technology can mean many different things to many different people. Different stakeholders are interested in different parts of this issue, ranging from general cultural development to workforce development to a desire for public financial and policy support. Internationally, this is demonstrated currently by the different emphases in different regions of the world, based on cultural and historic factors: public awareness is the dominant concern in Japan, public understanding is the focus in the United States, and public engagement dominates the discussions in Europe. Historically the informal science education (ISE) community—made up of public audience institutions (science and natural history museums, science centers, zoos, planetariums, and aquariums), media presentation channels (broadcast, cinematic, and interactive media such as television, radio, large-screen films like IMAX movies, online media, and publishing), and organized out-of-school activities—has offered significant opportunities to reach a wide audience with information on current research activities as well as to provide basic science and technology education.

Unlike formal education where the parental, structured, legal, and credentialed process provides the primary impetus for engagement, the ISE field operates in a world where the audience makes a deliberate decision to participate. This has led to a focus on the human side of the endeavor, whether it is through a presentation that engages the senses like a good exhibit or IMAX film, tells the story of real people doing real science with a documentary or a museum public program, or creates an opportunity for direct engagement through an after-school club or a discussion forum on science and society issues. Using exhibits, forums, and media, ISE institutions can play a unique role in public participation in nanotechnology as an intermediary between the world of science and the world of the public because of their existing audiences and facilities, their diverse design capacities, and their ability to move fluidly between the two worlds of formal and informal education.

Larry Bell, MS, Museum of Science, Boston

Public Engagement at Science Museums and through the NISE Net

Boston's Museum of Science serves as a public engagement partner for two Nanoscale Science and Engineering Centers in the Boston area, one headquartered at Harvard University and one at Northeastern University. The museum's public engagement activities have included live presentations

[1] Scheufele, Dietram A., and Bruce V. Lewenstein. 2005. The public and nanotechnology: How citizens make sense of emerging technologies. *Journal of Nanoparticle Research* **7**(6):659-667.

by museum staff and guest researchers in the museum's Current Science and Technology Center, exhibits and touch-screen media in the museum, online resources, an educator symposium, and regular broadcasts on New England Cable News. The museum, together with the Exploratorium of San Francisco, California, and the Science Museum of Minnesota, is leading the Nanoscale Informal Science Education Network (NISE Net), with 14 initial partners. This NSF-funded initiative has as its goal increasing public interest, understanding, and engagement with nanoscale science, engineering, and technology by creating a national network of informal science educators and nanotechnology researchers. The NISE Net is developing exhibits, programs, citizen forums, a media network, a visualization laboratory, graduate student professional development opportunities, a public website (http://nisenet.org/), and an online resource center for nanoscale informal educators.

Cynthia Needham, PhD, ICAN Productions

Nanotechnology: The Convergence of Science and Society

Most authorities agree that nanotechnology will play a major role in defining our future. At the same time, recent surveys reveal that members of the general public have little knowledge of, or interest in, nanotechnology. Acceptance of new technologies is often influenced by polarized views, sensationalism, and misinformation. We at ICAN Productions (http://smartscience.org/) hope to foster better mechanisms for respectful dialogue and decision making around some of the complex issues raised by this rapidly evolving field by seeking creative ways to engage the public early. This NSF-funded project, an innovative approach to attracting public interest in nanotechnology, examines the social, ethical, legal, environmental, and policy issues surrounding its potential applications through: (1) "Nanotechnology—The Power of Small" (http://powerofsmall.org/), a television series consisting of three one-hour nationally broadcast programs produced by Fred Friendly Seminars; (2) a seminar discussion guide emphasizing the interaction of science and society as well as presenting basic constructs for "nano literacy"; (3) a series of 90-second programs broadcast as part of the "Earth & Sky" radio series; and (4) a project website intended to host moderated forums to engage members of the public, scientists, policy experts, and others in an ongoing dialogue about the status of nanotechnology research and its potential impacts. Community-centered public forums coordinated by the Office of Public Understanding of Science of the American Association of the Advancement of Science (AAAS) will further engage stakeholders in 15 U.S. cities in dialogue regarding applications that may have an impact on their particular communities.

Panel 3-2. Engaging the Public in Science & Technology: "Participation in Action"

(Prior to Breakout Session C)

Kathy Hudson, PhD, Berman Institute of Bioethics, Johns Hopkins University

Genetic Town Halls

Active public engagement is essential to developing policies that reflect the wide range of perspectives that exist in America today. As part of an ongoing project, the Genetics and Public Policy Center at Johns Hopkins University investigated various means to understand the publics' attitudes about reproductive genetic technologies (RGT). Few models existed to demonstrate how to include an informed public in the genetic policy debate. Center organizers decided to use a "deliberative democracy" approach to a public consultation process to bring citizens, experts, and policymakers together in 2004 to learn from each other and deliberate about issues related to the use of RGTs. Two approaches to providing a deliberative democracy event were evaluated: (1) The Genetic Town Hall: Making Every Voice Count (http://www.pewtrusts.org/our_work_report_detail.aspx?id=35566), a modified town hall format held in six cities, and (2) online discussion groups (15 in all).

Town hall participants were recruited using community outreach. The 3-hour scripted sessions provided a balance of education and facilitated discussions. Online participants were recruited from a representative Internet-enabled panel and met online for one-hour moderated discussions for each of three weeks. Videos were developed to ensure uniform content in each setting; participants were queried before and after to document shifts in their opinions. A randomly selected control group completed identical pre- and post-surveys. In the town hall meetings, there were 536 participants; 133 participated online.

Shifts in attitudes occurred in both groups, most notably about appropriate uses of reproductive genetic testing

and the need for oversight. The town halls attracted more knowledgeable stakeholders; online participants were more representative of the general public. Town halls generated media coverage and the involvement of community leaders; online groups had more detailed discussion but had limited wider impact. Both approaches allowed for education and nuanced discussions. Depending on the goals of the public consultation, each has benefits and drawbacks.

Tom Beierle, MPA, Ross & Associates

Online Democracy

The National Dialogue on Public Involvement in EPA Decisions (http://network-democracy.org/epa-pip) was an online public dialogue sponsored by the Environmental Protection Agency that took place for two weeks in the summer of 2001. The EPA convened the dialogue to obtain input on its draft Public Involvement Policy (PIP) and to gather ideas on how best to implement the PIP. The model focused on encouraging considered deliberation among a large group of participants across the country.

The primary objective of the process was to provide EPA with information from a variety of viewpoints to help the agency develop its public participation policy and ideas for how best to implement the policy. The objective was explicitly not to build consensus. Secondary objectives were to open up new lines of communication between the public and agency staff, educate and inform those involved, test a new approach to public participation, and encourage formal comments on the policy.

Vence Bonham, JD, National Human Genome Research Institute, National Institutes of Health

Community-Based Forums

The National Human Genome Research Institute (NHGRI) is one of 27 institutes and centers of the National Institutes of Health. NHGRI established the Education and Community Involvement Branch in 2004 to lead its community engagement and public education programs. The branch is responsible for the development of the institute's education and community involvement programs to engage a broad range of the public in understanding genomics and accompanying ethical, legal, and social issues.

To further the public engagement mission of NHGRI, the institute established an annual public participation program, the "Community Genetics Forum," that awards contracts to academic institutions or community-based organizations to host, plan, implement, and evaluate public forums on genetics. The partner institutions work in collaboration with NHGRI staff to identify target audiences and develop community engagement strategies. Each host organization is a part of the engaged community and provides NHGRI with community expertise and perspectives in engaging the community. Each forum is evaluated to determine whether expectations were met, information was clear, participants learned new information, concerns were heard, and questions were adequately addressed.

Carolyn Lukensmeyer, PhD, AmericaSpeaks

21st Century Town Meetings

The 21st Century Town Meeting® model for public engagement is a large-scale model linking hundreds to a thousand or more participants to governance discussions (see http://americaspeaks.org/services/engaging-citizens). Marked by dialogue in table groupings, successful town hall meetings should have diversity among participants, informed dialogue (an educational component), facilitation and event support, polling enabled by wireless voting pads, reporting by teams, and distributed results. Critical success factors in town hall meetings include the following: every voice is at the table (both geographic and demographic diversity, including 50% "general interest" citizens); decision makers are involved at each step; there is appropriate content, structure, and process; and there are outcomes that make a difference. The decision-maker roles are defining the outcomes of the process, setting demographic targets, developing the content to be discussed, and making clear what can and cannot be influenced.

Chris Toumey, PhD, University of South Carolina

Citizens' Schools

As a powerful historic coincidence, discourses on participatory democracy and experiments in informal science education matured just when nanotechnology began to come to the attention of non-experts. The South Carolina Citizens' School of Nanotechnology (SCCSN) is an innovative approach for experimenting with different forms of dialogue between experts and non-experts. Its ethos and organization draw upon recent developments in the area of non-experts' involvement in science policy,

including participatory democracy and informal science education.

The five elements of the SCCSN model are (1) expert presenters who are adept at speaking with non-experts; (2) a package of readable articles to give participants background and confidence; (3) numerous opportunities for participants to question the experts and express their concerns; (4) size limited to 50 participants or fewer to ensure a friendly atmosphere; (5) iterative revisions from round to round in response to participants' suggestions.

The SCCSN model complements the "mini medical school" and "science café" models. It is more intimate than a mini medical school, more formal than a science café, and with its package of readings, provides more depth than either a mini medical school or a science café. Hypothetically, this model need not be limited to nanotechnology but could serve numerous topics in science and technology.

Leslie Bourquin, PhD, Michigan State University

Facilitating Engagement and Public Participation via Extension Service Outreach

Established by the Smith-Lever Act in 1914, Cooperative Extension ("the Extension") was designed as a partnership of the United States Department of Agriculture and the land-grant universities that originated with the Morrill Act in 1862. As stated in Section 1 of the Smith-Lever Act, the original mission of the Cooperative Extension Service was "to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture, home economics, and rural energy, and to encourage the application of the same" (42 U.S.C. 5901). Although many persons may be unaware of the Extension, most are familiar with some of the more visible Extension programs, such as 4-H.

During recent decades, the Extension has evolved from an organization focused primarily on dissemination of knowledge in agriculture and home economics (primarily utilizing a top-down teacher-student approach) to one that uses a more interactive approach to public engagement. No longer primarily focused on educating farmers, the Extension now has major programming efforts in urban as well as rural areas. In addition to its traditional programs in agriculture and natural resources, the Extension now includes core programs on family and consumer sciences, as well as on community and economic development.

As a model or vehicle for engaging public participation, the Extension has many strengths. The organization has a long history of being embedded in urban and rural communities—there are Extension offices and staff in most counties of the United States. These Extension educators are networked to faculty and Extension personnel in the land-grant universities as well as to USDA-CSREES[1] in Washington. Because the majority of funding for extension offices and personnel is derived from state and county budgets rather than from the Federal Government, the community-based staff are highly cognizant of the need to engage with the local clientele to determine programmatic needs. Thus, the Extension has evolved into an excellent example of an "engaged" institution that is well positioned to participate in and facilitate public discourse on issues and policies affecting persons from all walks of life.

Phil Macnaghten, PhD, Lancaster University, UK
(Luncheon Speaker, Day 2)

Nanotechnology and "Upstream" Public Engagement in the UK

Empirical research aimed at helping clarify the likely social and ethical dimensions of emerging nanotechnologies was conducted in the UK between 2004 and 2006. The purpose of the research was to develop a deeper insight into the sorts of issues likely to shape public attitudes and concerns. This was not an easy task. How do you research a topic about which most people have little or no opinion? How do you anticipate future public opinion?

The results, based on ten in-depth focus group discussions with assorted publics, present a picture of emergent public opinion in tension with existing literature on public attitudes towards nanotechnology. It highlights a latent ambivalence towards nanotechnologies and suggests that there may be public unease about potential implications. What is perhaps most interesting is that this ambivalence did not diminish through greater knowledge and awareness. Instead, through exposure to the multiple ways in which the debate was being characterized and through debate and deliberation, participants moved towards a more skeptical view as to the ability of government and industry to represent the public interest.

[1] This Department of Agriculture agency was reorganized in 2008 as the National Institute of Food and Agriculture (NIFA).

3. BREAKOUT SESSIONS

ORGANIZATION OF THE BREAKOUT SESSIONS

Workshop participants represented a wide range of professions, including academics; ethicists; physical, social, and behavioral scientists; Congressional staff; nonprofit and industry representatives; members of professional, civil society, and civic organizations; and representatives of national laboratories and Federal Government agencies. Workshop organizers divided the participants into six discussion groups, each representing a cross-section of the various interests and organizations of the workshop membership. After the speakers provided workshop participants with a framework for breakout session discussions (see Chapter 2), the six discussion groups separately addressed the topics of the presentations. In all, there were three groups of presentations and three related sets of breakout sessions. Each of the six discussion groups was charged with discussing one or more of eight specific questions related to the main topics presented by the speakers, as listed below.

Breakout Sessions A. What Outcomes Should Be Sought? (All 6 discussion groups addressed both questions.)

1. What key outcomes do we seek through public participation in nanotechnology?
2. What are the appropriate roles for the public in nanotechnology policymaking and decision making?

Breakout Sessions B. How Should Public Participation in Nanotechnology be Approached? (Each question was separately addressed by two discussion groups.)

3. Which nanotechnology issues should include public input in decision making?
4. Who should be sponsoring public participation? Who should be listening, and how do we get them to really listen?
5. Should nanotechnology be considered by itself or combined with other emerging technologies in a broader societal conversation?

Breakout Sessions C. How Should the Public be Engaged in Science and Technology? (Each question was separately addressed by two discussion groups.)

6. What does the public need to know about nanotechnology in order to participate meaningfully? To what extent should education be a component of public participation?
7. Is promoting open dialogue on nanotechnology enough? What types of processes and activities make sense for public input on nanotechnology?
8. Who are the "unengaged"? How can the unengaged become engaged? How can sponsors move beyond the traditional special interests and really engage the general public? To what extent should they try?

At the end of each breakout session, each of the six discussion groups reported on its discussions to the entire assembly of participants. This chapter summarizes the breakout discussions concerning the eight questions asked of the participants. Each session's summary begins with one or more representative comments from participants. A few longer participant "stories" are shown in sidebars among the breakout session summaries.

GENERAL OBSERVATIONS ABOUT THE BREAKOUT SESSIONS

> *I'm not sure we can talk about "a" public. There is no one public; it is disaggregated. We need a wide variety of approaches to public discussions.*[1]

The NNI workshop on public participation in nanotechnology experienced complexities in the group dynamics that are common to many public participation activities. For example, the participants who wanted more structured and concrete discussions experienced frustration when the discussions became more abstract. In many of the groups, there were strong tendencies, particularly in the earlier sessions, for group members to wander off-topic and pursue topics of individual interest rather than discuss the assigned question. Some

[1] Italicized text in this section represents paraphrased comments from workshop participants.

participants, for instance, focused on developing a group consensus about specific definitions for "public" and "public participation." Their discussions contributed to the "Terminology" sidebar in Chapter 1.

Even in breakout discussion groups that were better able to stay on-topic, some voices were diminished by more vocal participants. As an example, some industry representatives expressed reluctance to take part in certain discussions following anti-industry statements by other participants.

Public participation and engagement activities challenge participants to tolerate different points of views. As one workshop participant noted, public participation has intrinsic value toward increasing tolerance for discussions about complex issues and increasing appreciation for ranges of perspectives and opinions.

A Public Participation Story

Numerous examples were shared by workshop participants regarding public participation and engagement activities where the roles of the public and their inputs were not clearly defined. In most of these cases, workshop participants described people as "…just venting. There was no dialogue and no attempt to understand the views of others in the room."

A participant described "science cafés," a type of public engagement, as an effective way to "go where the people are." Held at universities where nanotechnology and other issues are discussed, this type of public engagement takes researchers out of the lab and into an informal public setting, such as a coffee shop, to talk about their work. To attract participants, advertisements are routinely distributed at the cafés, student centers, listserves, and rail and bus stops.

BREAKOUT SESSION DISCUSSIONS

Breakout Sessions A. What Outcomes Should Be Sought?

1. **What key outcomes do we seek through public participation in nanotechnology?**

   If the public were better engaged, policymakers would have more information and could make better decisions.

   An important outcome of engaging the public is education on the basics of nanotechnology. A better educated public could lead to better science policy.

   Showing students at an early age, or at an early stage in their careers, that there is a large pool of disciplines inside nanoscience and nanotechnology may expand [their career interests and thus] opportunities for a more diverse work force in the United States.

Some session participants were concerned that input from public participation activities is not valued by policymakers and asked, "Why have the public participate?" Other participants offered the following purposes for public engagement:

- Ensure that nanotechnology is developed in ways that reflect social norms
- Ensure that mechanisms are in place to keep the general public informed about and cognizant of scientific merit, technology development, safety, and oversight
- Provide appropriate education
- Provide advice to policymakers

Overall, workshop participants expressed high ideals for public participation activities. They talked about the value of listening to each other, understanding each others' concerns, gaining a greater public voice in policy matters, and, for government decision makers, having a more systematic, democratic means of gaining input on policy matters. Some participants expressed hope that public participation and engagement activities would create an enlightened, informed public; engender and maintain trust in government; make government decision making more transparent; empower the public; help scientists to connect with the public; encourage the next generation of technology workers; promote acceptance of nanotechnology development; assuage fears; gather more diverse inputs to policymaking; identify potential problem areas; shape policies that are more reflective of public values; and provide better nanotechnology-enabled products for all.

One session participant expressed the belief that influencing regulations should be the most important role of participation and engagement activities because private investment, rather than the Federal Government, is the primary source of nanotechnology funding. Another proposed that the sole desired outcome of public participation activities should be informing consumers.

Other participants questioned how much influence the public could have through public participation activities, especially on funding and regulatory decisions. Responding to this skepticism, other workshop participants argued that the public has contributed to shaping policy, citing the successes of AIDS activists and women's groups advocating for breast cancer research.

Some participants thought public participation activities could help "move nanotechnology forward intelligently" and that information from public participation activities could inform decisions about the best mechanisms to use to proceed responsibly with nanotechnology. However, some participants maintained that the value of nanotechnology and its real impact are not yet fully understood—although there was no agreement on these issues, and viewpoints varied greatly. Some participants questioned the premise that only highly knowledgeable people could make decisions regarding future applications of new technologies because their impacts are difficult to estimate without special training. Others stated that because the impact of the technology has been overwhelmingly positive, there is no need to speculate on its merit.

Some participants thought that in either case, nanotechnology is highly competitive and international in scope, and R&D will continue internationally, whether the United States actively supports it or not.

Whatever potential outcomes might motivate sponsors of public engagement activities, the public participation experts in the group stated that not all goals are advisable for public engagement activities. For example, they cited that public participation activities designed to shift opinions in a specific direction could be seen for what they are: an attempt to manipulate public opinion rather than being a forum for exchanging views. In this case, public participation and engagement billed under false pretenses would jeopardize trust and engender animosity rather than good will. The public participation experts strongly advised against arranging public participation activities as a public relations endeavor, particularly since public participation activities are designed to seek information regarding public interest and concerns rather than to promote particular special interests.

Some participants reacted favorably to the public participation experts' comments about striving for consensus as an achievable or desirable goal for public participation. However, others argued that trying to attain consensus is difficult to achieve, and that multiple solutions, rather than one, may be more suitable for the complex issues that nanotechnology raises. They maintained that generating a set of choices based on diverse perspectives could lead to better decisions and better-informed public policy.

Whatever the goals, the public participation practitioners counseled that public participation works best when clear questions are posed to people and specific recipients are targeted for information. Additionally, they stressed that public participation processes must be aligned with realistic goals in order to be successful, and that poorly executed public participation activities can thwart even the best intentions. For example, incomplete or inadequate discussion time can leave participants feeling disempowered and unheard and/or leave them with faulty conclusions. Some participants suggested planning for a few large-scale public participation activities, rather than several smaller events, as a way to reach large numbers of the public. Others questioned whether smaller-scale engagement activities would be more useful and practical than larger-scale events. This issue was left unresolved.

2. What are the appropriate roles for the public in nanotechnology policymaking and decision making?

We'd love people to be good learners, to come with smart, tough questions, contribute their values and concerns. If there is nothing on their minds yet, discussions will prepare them to think about what they hear.

I'm not convinced that the public has a role in policymaking. They're more interested in life, family, and job issues. Representative groups may play a more important role.

The public's role is to solve problems involving societal issues.

Overall, workshop participants generally agreed that the purpose of public involvement is to broaden public dialogue beyond the input of professional stakeholders, special interest groups, and scientific experts to ensure better-informed policy decisions. Many participants said that the role of the public is to provide a spectrum of input that would not be heard if discussions were limited to only those who are professionally engaged in policymaking or in influencing policy. Expanding on this point, some participants highlighted that the main asset

A Public Participation Story

One participant described a scenario that could increase distrust of public participation and engagement activities, in which input generated from a public participant activity was conveyed to decision makers, but no response from these decision makers was returned. This situation has the potential, one participant suggested, to heighten the public's overall mistrust of decision makers.

citizens bring to these dialogues is their personal values within the context of their daily lives, where they wear many hats; each person has several roles in society and could simultaneously be, for example, a teacher, parent, and consumer. Others suggested that in addition to their various roles, participating individuals should also possess qualities such as being good learners who are open to new and unfamiliar information and ideas, and effective communicators, so that decision makers can learn from their thoughts and perspectives.

Information generated from the breakout discussions reflected awareness by workshop participants that the role of the public depends on the publics who are involved, the sponsors, and the types of information sought. Some participants favored public participation activities aimed at gaining broader inputs about technologies, values, and potential products produced using nanotechnology. For example, one breakout group listed the following areas of input the public could provide policymakers:

- A hierarchy of values
- Wisdom
- Solutions to problems that have societal import
- Identification of concerns and needs
- Minority views
- Non-decision-maker views
- Political participation
- Public support indicators for policy-related decisions

Although a few participants expressed that the public ought to have significant input into all research and policy decisions, many had misgivings about citizens not possessing the requisite expertise to participate in making decisions in technically oriented areas of policymaking. As one participant said, "Would you want people who were uninformed to make important decisions for you?" For this group of participants, there was agreement that meaningful public dialogues cannot occur unless the public has some foundational knowledge about nanotechnology.

However, for many other participants, a lack of expertise was not regarded as a liability but as a welcome reality check to indicate how the general public and non-expert policymakers may respond when asked about nanotechnology issues. Other participants were skeptical about most citizens even wanting a role in policymaking, saying the United States is becoming an increasingly nonparticipatory society due to citizens' apathy, lack of time, and competing demands such as work and family.

Session participants noted that an absence of diversity in discussions due to activities attracting self-selected groups of motivated and interested individuals raised questions about the breadth of citizen representation in government. Representative groups were thought to play important roles in voicing the interests of unengaged individuals.

Several participants believed that nanotechnology is no different from other issues where public participation is a form of "intelligence gathering" for government officials to understand public issues and concerns. In this context, they felt citizens played a watchdog role for quality control, proper use of public funds, identification of potential concerns, and support for responsible development of technology. As one breakout group summarized, "The public is a social barometer of understanding how the technology is affecting people."

Breakout Sessions B. How Should Public Participation in Nanotechnology be Approached?

3. Which nanotechnology issues should include public input in decision making?

The public deserves input in areas where people are worried.

Public input is important for addressing regulatory issues. The marketplace will make some decisions.

Overall, the workshop participants who addressed this question generally agreed that the value of public participation activities lies in identifying public values

about nanotechnology to inform policymakers in their decision-making processes. Questions were also raised about whether there are policy issues that should be decided without public input.

One discussion group focused on policy issues where (1) the government would seek input and (2) topics addressed previously raised public concerns, including environmental, health, safety (EHS), and ethical, legal, and social implications (ELSI) issues. Workshop participants also identified the following areas where they believed public input should be widely sought:

- Medical technologies and their applications
- Invasive technologies that have a high potential to improve quality of life
- Intellectual property rights
- Environmental, energy, and sustainability issues
- Areas where nanotechnology could contribute
- Equity issues related to economic and social distributions of benefits, wealth, and risks
- Bioremediation
- Occupational and industrial safety issues
- The rate of technology development
- Questions regarding the limits of "How far is the public willing to experiment?"
- Market offerings vis à vis consumer choices
- Environmental regulations

For technically oriented decisions, many workshop participants voiced skepticism about the extent to which policy decisions are actually based on technical information. Especially in cases where a high degree of uncertainty exists about scientific outcomes, personal and institutional values rather than scientific data were seen as significantly influencing policy decision making. Participants expressed particular support for public input in such cases. For example, some participants suggested that policymakers should closely examine both technical and nontechnical factors when understanding toxicity, and should evaluate social perceptions about acceptable levels of toxicity along with the scientifically determined and governmentally accepted toxicity guidelines.

Numerous discussion group participants identified public discussion of regulation as an important topic for public participation activities. Participants recognized that the regulatory process is "the mechanism" for outside input to business decisions and that infrastructures for public input already exist and are occasionally mandated by law. They also stated that government, academia, and private sector interests about regulatory issues and technology development are deeply intertwined and suggested that the government should play an organizing role for public involvement in these areas.

Some participants believed decisions affecting public safety require greater levels of knowledge than could reasonably be expected from any non-expert group.

A range of opinions was also expressed about the appropriateness and/or need for public input on budgetary matters, including government funding levels and areas of investments. One participant stated, "The public should help define the goals of the NNI. Dollars are a proxy for goals, so the public should have input to the budget." While many agreed that public input could be valuable to inform the prioritization of investments, they still thought that issues of funding specific research projects are generally inappropriate for public input. Others thought that budget issues are too abstract to attract public interest and that the responsibility of elected officials to serve their constituents is sufficient as a representational proxy for public input. Questions were also raised about whether the government, through existing mechanisms, already adequately engages the public on budgetary matters.

4. Who should be sponsoring public participation? Who should be listening, and how do we get them to really listen?

Everyone should be listening to everyone else.

Those who need to listen are the groups who should be sponsoring public participation.

We need to create neutral spaces for dialogues.

Greater investment by the government in public participation activities was a key recommendation of the workshop. There was strong agreement among workshop participants that to address issues of trust and credibility, there should be a range of public participation and engagement sponsors who have (1) resources and capacity, (2) responsibility for decision making related to technology research and development, (3) motivation and ability to include and manage multiple

stakeholders holding different perspectives, and (4) good communications skills.

Even though participants acknowledged real and potential conflicts of interests, many felt that the Federal Government, including Congress, the Federal agencies, and elected officials, should be the primary sponsors of public participation activities because they have the capacity to capitalize on existing infrastructure, broadly implement activities, and disseminate information. Others agreed that although government and industry need to listen to public views, they questioned whether the public would regard government (or industry) sponsors as trustworthy, able to encourage the expression of a spectrum of opinions and/or to honestly consider broad input when making decisions, especially if these processes are to work in tandem.

Others suggested that the "honest brokers" should be public participation sponsors—that is, entities such as educational institutions, science centers, community-based groups, coalitions, the Better Business Bureau, and scientific societies—because they felt these groups are better informed about local norms and thus more sensitive interpreters of outputs than national entities. Even so, there was disagreement as to whether some of these organizations (e.g., scientific societies) are unbiased towards technological development.

A Public Participation Story

A workshop participant stressed the importance of credibility when planning public engagement activities. To engage local farmers about emerging nanotechnologies for farming and agricultural practice, a series of public engagement forums were coordinated through the regional USDA Cooperative Extension Office. Despite referrals and monetary incentives, involvement of local farmers was low, even when personal contacts were made. These farmers, many of whom previously had participated in other public participation activities, not only saw no relevance or potential benefit from attending, but as the organizers later learned, the farmers were critical and resistant to talking with nanotechnology researchers because they felt the researchers lacked an understanding of farming.

When asked, "Who should be listening?" participants suggested a range of stakeholders, including scientists, researchers, public and private funders, and the citizenry. Moreover, participants felt that the government, including regulators, policymakers, and lawmakers, is the most vital recipient of information gathered in public participation activities. There was broad consensus that public servants should pay particular attention to the interests and concerns of the public because of the government's fiduciary, policy, and gatekeeping roles and responsibilities.

When asked how to increase the likelihood of public inputs being heard and heeded by decision makers, discussants stressed that in any public participation and engagement activity, all parties, especially funders, need credibility and should inform the public of any conflicts of interest, whether real or apparent. They also emphasized that diversity among participants is an essential criterion, because broad spectra of viewpoints are more informative and credible than debates dominated by a few. This last point was emphasized by some workshop participants because they felt policymakers tend to ignore or minimize issues when singular or extreme views are the only ones available. They urged that although more difficult to organize, a broad range of people and perspectives need to be included to increase the likelihood that the public participation activity will generate trusted information.

Overall, participants held a range of opinions about the desire or incentive for industry to engage in public participation, ranging from having no interest to being fully invested in public engagement processes. Several participants said it was important to have industry participation and cautioned against assuming that industry members hold different value sets than those in the "public" sector, an assumption that may need further investigation.

A few participants felt that an organized public participation effort was unnecessary since the marketplace reflects consumer preferences. This view was problematic for others who felt that product purchasing was not an adequate proxy for public participation activities because advertising and less-than-full disclosure regarding specific products could compel purchasing and not reflect a thorough understanding on the part of the consumer of nanotechnology-based products and other product-related issues.

Several participants added that not just public participation activities were important to the discussion, but also the issue of responsibility to inform the public about technological impacts. Questions were raised regarding ownership of responsibility to inform the public, with many believing it was a responsibility shared by government and industry. Within this context, participants suggested that organizations, including the government, should improve the communication infrastructure and develop better methods for the collection, retrieval, and dissemination of information. As one participant stated, "There is not one but many bureaucracies that public opinion must penetrate to make a difference."

5. Should nanotechnology be considered by itself or combined with other emerging technologies in a broader societal conversation?

Nanotechnology is so far along that breaking the discussion into separate pieces would be difficult at this stage.

The unity of the research agenda doesn't carry across to unity in applications.

The technological issues of societal importance are the same across research fields. Nanotechnology must be included with other emerging technologies for public discussion.

Although a range of perspectives was expressed by workshop participants, there was considerable agreement that multiple approaches should be used to increase the public's understanding of nanotechnology, other emerging technologies, and related issues.

Proponents of public participation and engagement activities exclusively focusing on nanotechnology-specific applications supported their position by arguing that nanotechnology has specific and unique attributes and concerns that differ from those of other emerging technologies. They felt that when a question is framed too broadly, such as "Is chemistry safe?" or "How do you feel about nanotechnology?" it is difficult to elicit meaningful discussions. On this point, they felt the public could be better engaged and have more meaningful discussions only if there were a focus on specific nanotechnology applications that simultaneously illustrate nanotechnology's multidisciplinary, hybrid nature. For example, bionanoinformatics could be viewed through the lenses of biological and information technologies.

Other participants had difficulty distinguishing nanotechnology from other technology sectors and wondered if nanotechnology had a unique place in the field of emerging technology or whether nanotechnology was being used as a surrogate for technology and emerging technology issues in general. Suggestions were made to discuss nanotechnology within the context of emerging technologies, as opposed to nanotechnology in isolation. These participants believed that general nanotechnology-focused discussions could have less public appeal, or if they did occur, could result in accelerating and generalizing fears of nanotechnology because the public would not have an understanding of nanotechnology or its specific issues.

Despite disagreement on whether the subject of nanotechnology is unique or should be combined with other emerging technologies, there was general agreement by the participants on the need for an informed public if public input is to be useful. But how informed should the public be about nanotechnology?

Some participants maintained that a baseline knowledge about nanotechnology is needed for participants to be fully engaged in discussions about nanotechnology. Others disagreed, stating that regardless of whether people are ill-informed or uninformed about nanotechnology (or other technologies), they still have values, fears, and concerns related to technology development writ large. From this vantage point, these participants made a case for soliciting broad, nontechnical public input as being useful in discussions focused on multiple technologies, areas of technology convergence, and the ways in which these technologies affect their lives. On this point, one participant noted the public's general acceptance of the Internet without mastering significant technical knowledge of its "nuts and bolts"; its implementation and improvements have been deferred to technical experts. This participant added that technical expertise in nanotechnology and other relevant scientific domains such as information technology and chemistry is not a prerequisite to raising important ethical, legal, and societal issues about privacy or human enhancement.

In any case, many participants recommended that education and public information campaigns should

be undertaken either preceding public input or simultaneously while soliciting public input.

Breakout Sessions C. How Should the Public be Engaged in Science and Technology?

6. **What does the public need to know about nanotechnology in order to meaningfully participate? To what extent should education be a component of public participation?**

   Unless the government creates a vision [for nanotechnology], activists and special interest groups will create their own version if no other mechanism emerges for developing a public vision.

   Experiences from genetically modified organisms and food issues showed [the public has had] a fundamental misunderstanding about science.

   It's a mistake to engage the public in "nano" as the topic. An accident with one particular product could lead to all nanotechnology products being painted with the same brush.

Overall, workshop participants in the sessions that addressed this question felt the public did not need to have specific expertise but rather a general understanding of nanotechnology to participate in nanotechnology-related public participation activities. On this point, in nearly every breakout group, education was raised as being critical to productive public participation activities. Although most participants believed that educational efforts about nanotechnology for the general public would increase the number of people who would participate in public discussions, some skeptics found it difficult to envision having productive discussions when relatively few Americans are even aware of nanotechnology.

A number of general educational goals were identified (but not prioritized):

- Provide basic information about the designated topic for informed discussions
- Support nanotechnology literacy for wider audiences (virtually every public)
- Distinguish fact from fiction
- Promote responsible development of nanotechnology
- Promote interest in identifying and discussing research and societal issues
- Promote awareness of how nanotechnologies can address critical challenges facing humanity today

Several essential public education content items and questions were also identified (but not prioritized):

- Nanomaterials are not new; what is new is the ability of scientists to manipulate atoms to engineer new materials and properties at that scale
- Properties differ at the nanoscale
- How is nano "done" and by whom?
- What are current and potential applications?
- What are the oversight and regulatory processes?
- How are benefit and risk assessment done?
- How should society address uncertainty related to nanotechnology?
- What are similarities and differences between nanotechnology and other technologies?
- What ethical, legal, economic, and societal issues are raised by nanotechnology applications?

Many workshop participants believed that in the absence of accessible information, special interest groups were manipulating public opinion and sentiment by creating misleading materials. For example, some participants felt that media has played a major role in misrepresenting or skewing information about nanotechnology as dangerous by presenting risk (rather than benefit) messages using emotional, not science-based, arguments. On this point, one workshop participant noted the importance of engaging the public early, before positions solidify based on sensationalized information from media or advocacy groups.

A Public Participation Story

A community college biology teacher found he could incorporate nanotechnology into both his science and his civics lessons. He taught the course material by framing it within the personal context of how nanotechnology would affect the students' lives. "If you want to be an educated voter, what you learn in biology class can help you. You'll become an informed decision maker on some important public issues."

Many participants noted that inaccurate information potentially can obstruct development of highly beneficial technology applications in medicine, energy, environmental remediation, or other areas. For example, some participants raised concerns about aggregating environmental, health, safety, and ethical issues, saying that doing so could lead to misinterpreting nanotechnology issues as monolithic, wherein a problem in one area could be extrapolated to form incorrect assumptions about other areas.

Participants suggested educating broader segments of the population. One suggestion was to work with television networks to help them incorporate nanotechnology into television shows such as sitcoms, which reach more people than educational media do. They also proposed the use of traveling exhibitions that stop in rural communities. Even in these cases, participants cautioned against using perception management or public relations as replacements for education.

7. **Is promoting open dialogue on nanotechnology enough? What types of processes and activities make sense for public input on nanotechnology?**

   There should be more public expression of expectations for this magical technology.

   Public participation should clarify how "nano" issues will be governed.

   Policymakers need to hear "raw" public issues, concerns, and perceptions, not what they hear through media or other special interest groups.

Public dialogues were viewed by many workshop participants as a powerful way of preparing citizens to exercise influence in policy decisions affecting their lives. In general, open dialogues were seen as effective vehicles for mutual information sharing and for building trust for future public engagement activities when specific inputs on policy-related issues are needed.

While many models for public participation were discussed, public participation practitioners emphasized that the models chosen for any public participation activity should be driven by the goals of the planned activity. There is no one-size-fits-all approach to public participation; different models will be required for different audiences and intended outcomes. Particular activities need to be organized to meet particular goals. In a case where the goal is reaching a consensus or obtaining a recommendation on a particular topic, public participation practitioners suggested that small group discussions and deliberations would be the most manageable and effective types of activity.

Although many workshop participants expressed hopes that the public would be consulted on specific policy-related issues, many participants also indicated that general dialogues about nanotechnology and the issues it raises would be valuable in and of themselves. Here, public dialogues were viewed as especially useful for both the sponsors and the involved citizens when the goals of engagement are educational. With no agenda beyond the opportunity to educate people about what is and is not nanotechnology, dialogues were seen as opportunities to increase understanding about nanotechnology, as well as about the issues related to and emerging from nanotechnology. Others agreed and supported the idea that in the absence of a specific policy issue, education-based dialogues, rather than other forms of public participation, would best serve the general public to increase knowledge about nanotechnology.

8. **Who are the "unengaged"? How can the unengaged become engaged? How can sponsors move beyond the traditional special interests and really engage the general public? To what extent should they try?**

   I'm not sure that engaging everyone should be the ultimate goal.

   The vulnerable, inarticulate, and most affected persons also need seats at the table.

   You cannot expect people to come to you; you have to go out and find people.

Many participants stressed that public participation and outreach efforts will need to reach beyond the scientifically informed and interested people who already are participating in public discussions. Workshop participants readily acknowledged that a major challenge to involving larger segments of society is motivating disinterested segments of the public to become involved in discussions on technology and public policy matters.

Workshop participants generally agreed that education is one of the best means to engage a broad audience. They felt that the more people know about nanotechnology issues, the greater the likelihood they will have a stake in its development. This knowledge would allow individuals to identify the ways in which nanotechnology

A Public Participation Story

Workshop participants who were associated with science centers noted that public dialogues can attract the attention of decision makers who attend science center and museum events as a means of connecting with their constituents. These activities, often built around expert presentations and question-and-answer sessions, have provided forums for policymakers to learn about nanotechnology while discovering constituent concerns and questions.

One participant shared an example of workplace and laboratory issues relative to hearing protection. Working with the National Institute for Occupational Health and Safety (NIOSH), this participant taught employees, high school instructors, and trade groups about hearing protection guidelines and found out from them what precautions were being practiced. The participant was successful in engaging workers only when he took them away from their normal job environments. When workers left the job site, they devoted greater attention to discussions than they had in the workplace; the change in location apparently emphasized the importance of the activity and, perhaps, eliminated distractions. NIOSH often uses existing social networks to successfully engage the public.

development is relevant to their lives. Many agreed that this self-interested perspective may be a powerful motivator for individuals to seek out information and participate in outreach activities.

Other strategies to increase public awareness and better engage the general public about nanotechnology were suggested, including the development of materials that use plain language when describing ideas and concepts (http://www.plainlanguage.gov/index.cfm). Also suggested as a prudent course of action is providing alternative levels of participation based upon individual interest levels and the range of information needed by decision makers.

However, in these efforts, many participants cautioned that public participation activities should not be used as a replacement for science education. For either public engagement or educational outreach, discussants called for a thoughtful planning process that includes a broad range of publics to ensure that a wide range of social values and perspectives are captured.

Generating interest in nanotechnology with unengaged individuals will involve identifying issues—such as environmental remediation, medical diagnostics and treatments, clean and renewable energies, and clean water—with relevance to people's lives. Participants suggested using products that have already been developed or are expected to be developed through nanotechnology as examples when discussing benefit-risk analyses and environmental, health, safety, and ethics issues.

In many groups, there was opposition to speculating about risks associated with nanotechnology and nanomaterials as a way to raise public interest in nanotechnology. Some advocacy and special interest groups were viewed as elevating nanotechnology risk profiles without scientific support in order to achieve their own policy-related and funding goals. On this point, some participants felt that because alarmist information could result in various negative consequences, careful and informed measures are necessary to counter such tactics.

Because local and regional concerns were acknowledged as potential drivers for public interest and participation, suggestions were made to "go to where the people go." By identifying existing infrastructures and mobilizing local community-based organizations, such as parent-teacher associations (PTAs), civic and business organizations,

A Public Participation Story

A workshop participant involved with pesticide-application safety training worked with the U.S. Environmental Protection Agency to create a national network of public forums and discussion groups to educate the public. To raise awareness and encourage participation, he used established listserves, newsletters, and word of mouth to bring previously unengaged people to the discussion.

and "watchdog" groups, the people and organizations that want to plan nanotechnology public participation activities can collaborate with those already doing outreach rather than create new capacity. In order to maximize public participation in marginalized and underserved communities, participants considered it essential to advertise nanotechnology public participation activities using the broadest possible means of conveyance: Internet blogs; politicians; public interest groups; community, professional, and industrial associations; and personal outreach.

Ultimately, participants stated, individuals will decide themselves whether to engage in public dialogues and what structures are comfortable for them.

4. WORKSHOP RECOMMENDATIONS[1]

At this workshop on public participation in nanotechnology, widely divergent opinions were expressed in both the plenary and smaller group discussions. Participants raised many important issues while working to answer the questions asked of them. Notwithstanding the breadth of the discussions, workshop participants identified a number of specific recommendations. They also identified a number of key challenges that they felt the NSET subcommittee and NNI participating agencies should address as they take steps to better involve the public in the nation's nanotechnology endeavors.

SPECIFIC RECOMMENDATIONS

A sampling of the recommendations offered by individual participants includes the following:

- *Scale up:* Identify possibilities for convening more public participation workshops to engage greater numbers of people and to determine the breadth of the public's existing knowledge: What is known? What needs to be known? Who is doing what?
- *Prioritize:* Identify issues on which policymakers and stakeholders should have public input.
- *"Just do it":* Initiate public participation activities using iterative, multitiered processes, and evaluate the efficacy of various engagement methods.
- *Solicit event sponsorship:* Seek public and private sponsors for public participation activities.
- *Identify "publics":* Identify a wide range of publics and stakeholders to engage in immediate, mid-term, and longer-term participation efforts.
- *Apply experience:* Learn from the research literature, formal and informal education communities, and prior public participation and engagement efforts (e.g., the UK's NanoJury and NanoDialogues experiences).
- *Coordinate with educational activities:* Develop public engagement activities that are complementary to existing science education curricula.
- *Do research:* Identify public participation research needs to develop best practices for nanotechnology and other emerging technologies.
- *Distribute guidelines:* Provide guidelines to agencies, departments, and other groups about public participation approaches.
- *Develop materials for public participation events:* Identify what information should be targeted for inclusion in nanotechnology-related public participation activities, and where gaps exist, develop science-supported, plain-language materials for use in public participation and engagement activities.
- *Improve risk communication:* Create theory-based and research-supported guidance for risk/benefit communications.
- *Address structural challenges:* Examine and address issues related to funding, sponsorship, and channels for meaningful input.
- *Improve public education:* Explore ways of increasing nanotechnology awareness and stakeholder education.
- *Include program evaluation:* Identify and apply public participation outputs and metrics to evaluate public participation activities.

KEY CHALLENGES TO BE ADDRESSED

Grand Challenges

Workshop participants agreed that a grand challenge for public participation planning is to establish and maintain public trust in public engagement activities and in the sponsors of those activities. Whether government and industry can serve as impartial public participation sponsors and conveners will depend on whether participants can trust them to be impartial. Nonetheless,

[1] These are not consensus recommendations but rather are intended to reflect the diverse views, expertise, and deliberations of the workshop participants.

many workshop participants said that the government should sponsor public participation and education-related nanotechnology activities because it is best equipped with resources, credibility, and knowledge about nanotechnology.

A related challenge is developing materials perceived to be unbiased, especially because vocal, special interest groups with narrow perspectives also produce informational materials. Workshop participants suggested using independent third-party reviews to increase the trust and credibility of government- and industry-produced informational materials.

Structural Challenges

A public participation strategic plan for the NNI will need to identify and prioritize topics and strategies to successfully implement productive, large-scale, far-reaching public engagement activities. To do this, workshop participants identified the following structural meta-challenges that need to be addressed and overcome.

Generate a Paradigm Shift

A paradigm shift is needed so that policymakers actively formulate questions and seek broad public input. Currently, U.S. Federal agency processes, except for those of regulatory agencies, lack structures and mechanisms for public input.

Fund Coordination of Public Engagement Activities

The workshop participants learned that the National Nanotechnology Coordination Office (NNCO), which supports the efforts of the NSET Subcommittee, was not tasked to conduct public participation activities. Government public participation activities are funded by the research budgets of some NNI participating agencies. In some research agencies, the social and behavioral sciences branches fund these activities. If the Federal Government is expected to implement coordinated nanotechnology-focused public participation activities, then additional mechanisms will be needed to fund, develop, and implement these activities in ways that will effectively serve the broad publics and inform policy development processes across agencies, the Executive Offices, and Congress. Some workshop participants suggested that NNCO should be tasked to coordinate interagency public participation activities.

Address the High Cost of Engagement Activities

Regardless of the funding source, public participation activities were recognized by participants as being expensive. According to some public participation experts, town hall meetings involving 1,000 or more participants can cost nearly a million dollars. Although smaller-scale public participation activities such as consensus panels may be more agile and less expensive, it will still be costly to engage a nationally representative sample of citizens. Therefore, funding of public participation in nanotechnology should be sufficient for a larger-scale or a number of smaller regional and national efforts.

Subject Matter Challenges

Generate Interest

Many workshop participants acknowledged the difficulties in attracting broad and representative publics to nanotechnology-related activities, especially when most surveys and polls at the time of the workshop reported that the general public had little or no knowledge, interest, and/or awareness about nanotechnology.

Other workshop participants were emphatic that public concerns exist about nanotechnology, reflecting interest that could be tapped for public discussions. Other participants indicated that some of the surveys indicating public concern about nanotechnology are the subject of debate among social and behavioral scientists. Workshop participants generally agreed that the general public's ignorance about nanoscience and nanotechnology can make discussions about nanotechnology difficult, unproductive, and unreliable. Some participants suggested that active outreach to specific, previously unengaged publics may be needed, especially for those participants who are unaware that they are recipients or beneficiaries of technological developments.

Other participants stated that citizens interested in participating in discussions about more technical aspects of technology development and applications may need additional information to augment their baseline knowledge.

In any case, workshop participants recognized the difficulty of increasing interest in nanotechnology—or science in general—among unaware and uninterested

persons. Because uninterested citizens may be more willing to participate in public discussions where they find personal relevance in the topic, some workshop participants suggested demonstrating personal connections to a subject as a way of engaging citizen interest. Others were more skeptical, citing examples of science-supported nanotechnology applications such as sunscreens that have not generally captured the public's interest. Some workshop participants stated that this may be due to the fact that many of the products that employ nanotechnologies are not identified as such, either because they have undergone incremental improvements (e.g., nanomaterials enhancements in various products range from stain-resistant clothing to more-resilient tennis racquets, lighter-weight bicycles, glare-resistant eyeglass coatings, and faster computer chips) or because they are not yet in widespread use (e.g., fire- and decay-resistant wood and paper products, more efficient and environmentally sound energy production, novel means to identify disease or precisely target medical therapies, and embedded decay sensing capabilities in food packaging). Awareness issues appear to be closely associated with education issues.

Address Education Issues

It is a challenge to clearly convey information about nanoscale science, engineering, and technology and their applications. Participants agreed that learning about the nanoscale world can be conceptually challenging for novices and experts alike, due to difficulties in conceptualizing the nanoscale and associated properties that may be very different from those at the microscopic and macroscopic scales.

Participants also agreed that compounding these issues is the fact that nanotechnology is not a monolithic but an enabling technology, with applications as diverse as electronics, cancer therapy, food packaging, and energy storage. Educators will be challenged with developing educational materials that identify "common denominators" across nanotechnology application areas and yet avoid framing the commonalities so broadly as to suggest that characteristics of certain nanomaterials, either positive or negative, are attributable to all nanomaterials. Because of this, some workshop participants recommended that discussions about nanoscience and nanotechnology should be focused on issues related to specific applications and technological outcomes, identified products and materials, and specific questions whose answers will inform policymakers.

Additionally, many workshop participants, educators in particular, strongly felt that public participation activities should be responsive to and tailored to the needs and interests of individual audiences. For example, a business-oriented group may relate better to information about emerging markets, patient groups may be more interested in biomedical applications, environmentalists might be more interested in risk-related research, and so forth. Thus, demographics, educational levels, and audience interests should be taken into account when determining what approaches should be taken in public outreach activities and what content areas should be discussed. It was suggested that educators should determine the scope and depth of information to be presented to diverse participation groups, with care to avoid too-detailed information that could result in failing to adequately educate and engage the nonscientific public.

Educators are already working on developing effective approaches to teaching about the nanoscale and applying these approaches where informed, productive engagement is the goal. For example, the National Science Foundation is supporting work in the area of informal education through the Nanotechnology Informal Science Education Network (NISE Net, http://www.nisenet.org/), where individuals can choose what they want to learn through different approaches such as exhibits, interactive learning, and public engagement.

Workshop participants suggested several other ways to educate a broader segment of the population, including incorporating nanotechnology into television shows such as sitcoms, which reach more people than do the educational media. Also proposed was the use of traveling exhibitions[1] that can visit rural communities. Some participants identified the key audiences for educational outreach as children, teachers, and parents.

Improve Risk Communication

Education is an iterative, not a straightforward, process where information is imparted and received as intended. Risk communicators at the workshop noted that personal risk assessment is not a rational process; rather, individuals have their own ways of perceiving

[1] An example is the NanoExpress (http://nnin.org/nnin_howard.html), a traveling exhibit of a nanotechnology laboratory, complete with instrumentation.

and evaluating risks reflecting personal experiences and attitudes rather than relying on quantified information regarding hazard and exposure, which are the two elements of risk.

Workshop participants discussed the challenges of public participation in responsible scientific and policy development when so many uncertainties about nanotechnology exist. For example, some felt that information cannot be "force fed" to the public, because learning and personal risk assessment is based on both information and personal experiences. Given the impossibility of anticipating every nanotechnology application or impact, some participants suggested risk assessment and risk communications will need to be integrated on an ongoing basis into public participation activities to ensure that nanoscience, nanotechnology, and their applications are discussed in ways that are understandable to the public at large and that support responsible technology development.

Because of the perceived difficulties involved in engaging broad segments of the public in nanotechnology, and because of a sense of urgency to begin a serious national dialogue on associated risks, a small group of participants felt it may be justified to portray the potential risks of nanotechnology in "dramatic fashion"—just to get the dialogue started. Other participants, however, stated that they felt any presentations that could be construed as "scare tactics," or negative portrayals of nanotechnology that are unsupported by science, are unethical and should not be condoned. Further, such tactics may be impractical and self-defeating, because as several risk communications experts pointed out, it may be difficult or impossible later to correct exaggerated, biased, and unfounded risk perceptions—even by presenting appropriately balanced and supported information. Thus, the nation could lose potential benefits in the course of avoiding unsubstantiated risks.

Supporting these points, some researchers discussed the dearth of information available about the impacts on policy of public discussions about potential risk. For example, discussions of risk—potential or extant—might increase perceptions of risk beyond what is supported by the science-based evidence. This possibility raises the question as to whether such risk discussions are in the public interest. Research is underway to gain more information about the potential impacts of conducting public participation early in the development of a technology. Further research is also needed on how best to convey scientific information, including that related to risk, to improve the public's understanding about nanotechnology.

Science communicators at the workshop spoke of the difficulty of interesting citizens in basic science, the stage where much nanotechnology-related R&D is today. Because the uninterested citizen is more likely to participate in public discussions where he/she has a personal stake, framing discussions for personal relevance is a reasonable option for public participation activities. Providing concrete, compelling examples of current nanotechnology applications, therefore, would be very helpful in promoting such engagement, participants noted.

Some participants observed that few examples existed in the marketplace at the time of the workshop. Although there were incremental improvements in various products (often invisible to the naked eye) due to using engineered nanomaterials, these applications did not generally excite the public. More compelling examples of nanotechnology applications are now beginning to emerge, especially some that are related to medicine.

There was some debate among participants concerning the extent to which the public already may harbor fears about the risks associated with nanotechnology, and whether such fears can be "undone." Some participants suggested that public participation is required to address existing public fears about nanotechnology, whether "rational" or not. Risk communications experts noted that remedying inaccurate perceptions may be difficult, especially after risk perceptions have already been unrealistically elevated. Other participants challenged the existence of widespread fears, on the basis that public knowledge on the subject remains low overall. Questions also were raised about survey methodologies that ask respondents questions about nanotechnology after the respondents have indicated that they have no knowledge of the subject. Particularly problematic, it was noted, are some survey findings that had claimed to quantify nanotechnology-related concern based on information that respondents were given during the survey process.

Such "instantiation"[1] related to risk and nanotechnology is the subject of debate among social and behavioral scientists today.

Consider Timing

When participants were asked when public participation activities are most useful, many believed these activities can achieve better outcomes when the personal opinions of participants in such activities are less entrenched. Thus, they contended that public participation and input activities held relatively "upstream" (early) in the nanotechnology research and development process are likely to be more effective than events held relatively more "downstream" (later) and closer to product commercialization. Participants suggested that these upstream public participation activities, if done early, frequently, and critically, could effectively inform both the public and the policymakers about the state of the science and minimize unfounded fears about nanotechnology. They felt this strategy could be particularly helpful in discussions about resources and R&D planning.

Counter to the upstream perspective, advocates of downstream public engagement believed that, absent tangible, high-profile products, the public has little point of reference for or interest in nanotechnology discussions early in the R&D stream. They felt discussions should occur only when socially significant applications and products become available in order to avoid having speculative rather than science-supported discussions about nanotechnology. However, critics of downstream public engagements used the debate in the United Kingdom about genetically modified (GM) food as a cautionary example. Whether due to GM foods already being in markets when public discussions began, public outrage at the late timing of decision-making processes or at skewed, nonrepresentative participation in the dialogues, the late-stage involvement of the citizenry cost the national dialogues their credibility.

Other workshop participants proposed a compromise position by suggesting the public be engaged at all stages of development to ensure better policy outcomes. For example, they thought public engagement activities should be responsive to different products, product categories, and applications regarding potential nanotechnology benefits and risks at different times, because presently disengaged publics might tomorrow be actively engaged.

Evaluate Public Participation

In order to measure outcomes, practitioners noted that public participation activities must have clearly stated goals and measurable outcomes based, at least in part, on participant expectations. There was some discussion of the best indicators of successful activities. One participant noted that, "We don't do public participation for the sake of doing it." The evaluation measures that workshop participants suggested fell into three general categories:

1. *Procedural:* Query whether everyone got a chance to be heard and whether they "felt" heard.
2. *Formative*: Measure participants' knowledge of both what was learned and what was shared.
3. *Summative*: Evaluate outcomes against the stated goals of a particular activity.

Overall, the participants believed that all three categories of outcomes evaluation of public participation efforts—procedural, formative, and summative—are necessary to understanding the effectiveness of the activities and materials. However, workshop participants also acknowledged that developing evaluation metrics will be challenging, due to a general lack of agreement on how to identify, define, and measure the best indicators of effective public participation activities.

[1] Reporting risk where respondents had no knowledge of the subject matter or sense of risk prior to a survey.

5. CONCLUSIONS

The experts, practitioners, researchers, and stakeholders—including previously unengaged citizens—who attended this workshop contributed valuable information and insights for planning public participation activities related to nanotechnology as well as for future discussions about public participation research and best practices. The thoughtful and, at times, challenging points raised by different stakeholder groups at the workshop signalled the importance and complexity of planning and implementing public participation in nanotechnology. The member agencies of the NSET Subcommittee, the interagency body responsible for coordination of the National Nanotechnology Initiative, found the information gained from this workshop to be extremely valuable.

A clear message heard from this workshop is that public participation activities are reciprocal, "two-way streets." Unlike some traditional education models where participants are solely receivers of knowledge, public participation activities involve mutual learning.

Participants agreed that the best public participation practices should be implemented in activities organized for public participation in nanotechnology, including clearly defining topics, expectations, and outcomes. For example, there was considerable support for specific rather than general discussions about nanotechnology applications. Many participants believed this approach will produce more useful information for policymakers than will general discussions covering broader topics.

In circumstances where participants' knowledge about nanotechnology and/or a specific application area is insufficient, education, relying on a variety of teaching and learning methods, was seen as a necessary element in public participation activities. Workshop participants conceded that in some instances, technical discussions during public participation activities may require expertise exceeding that possessed by most members of the public. Nevertheless, with a mindset of willingness to delve into scientific and technical matters, members of the various publics will offer valuable perspectives about nanotechnology and its applications in public participation activities, including about issues related to the ethical, legal, economic, and societal implications of nanotechnology.

Where To From Here?

The NNI agencies support activities that involve the public in productive discussions about policy-related issues pertaining to nanotechnology. They also support conducting research on public participation towards developing best practices in the field. Input from this workshop will contribute to ongoing discussions and planning for future public participation and outreach activities undertaken by NNI agencies, the NNCO, and the Nanotechnology Public Engagement and Communications (NPEC) Working Group, which the NSET Subcommittee chartered in 2008 to provide strategic planning for public outreach, engagement, and communications activities.

APPENDIX A. WORKSHOP AGENDA

TUESDAY, MAY 30, 2006

8:00 AM Registration and Continental Breakfast

8:30 – 9:10 AM Nanotechnology Primer

Overview presentation of nanotechnology, how it is being used, areas of research, and its future potential.

Carl Batt, Cornell University

9:10 – 9:30 AM Welcome and Workshop Orientation

Clayton Teague, National Nanotechnology Coordination Office

Douglas Sarno, The Perspectives Group

9:30 – 10:45 AM Panel 1. Why Participation?

This panel will explore reasons why public participation is an important consideration in nanotechnology policymaking and decision making. Each panelist will speak for 15 minutes; a 30-minute question-and-answer period facilitated by a moderator will follow.

Carolyn Lukensmeyer, AmericaSpeaks

Why Do Public Participation?

- Why engage the public in policy-related decisions?
- What are the elements of good public engagement?

David Guston, Arizona State University

What Do We Want to Learn from Public Participation in Nanotechnology?

- What challenges and issues face society in the development and implementation of nanotechnology?
- What meaningful outcomes should we seek when engaging the public?

Rosalyn Berne, University of Virginia

The Ethical Dimensions of Public Dialogue in Nanotechnology

- What ethical issues are related to public participation, to nanotechnology, and how can we involve scientists in the discussions?

10:45 – 12:15 PM Breakout Groups A: What Outcomes Should We Seek?

Participants will be divided into six groups that are representative of the full range of interests and perspectives at the workshop to discuss the questions:

1. What key outcomes do we seek through public participation in nanotechnology?
2. What are the appropriate roles for the public in nanotechnology policymaking and decision making?

12:15 – 1:30 PM Luncheon Speaker and Lunch

David Ropeik, Harvard School of Public Health

Nanotechnology and Risk Perception

- How are risk perceptions formed?
- What issues will affect risk perceptions related to nanotechnology?
- How can the scientific complexities of risk assessment be communicated effectively?

1:30 – 2:00 PM Breakout Group A Reports

2:00 – 3:15 PM Panel 2. Planning for Public Participation

This panel will explore best practices in public participation as well as what we have learned to date about the public's interest, knowledge, and opinions about nanotechnology. Each panelist will speak for 15 minutes; a 30-minute question-and-answer period facilitated by a moderator will follow.

Douglas Sarno, The Perspectives Group

Best Practices and Processes for Public Participation

- How can we plan for successful public participation, including selecting the right level of participation, designing inclusive participation, and matching techniques appropriate to objectives?

Barbara Herr Harthorn, University of California, Santa Barbara

How Do We Identify the Publics to be Engaged in Nanotechnology?

- What issues are involved in identifying and engaging publics?

- What factors shape involvement, understanding, and opinion?

Dietram Scheufele, University of Wisconsin-Madison

What Do We Know About Public Opinion?

- How are public attitudes toward science and technology shaped?

- What is the role of media in shaping public opinion?

3:15 – 3:30 PM Break

3:30 – 5:00 PM Breakout Groups B: How Should We Approach Public Participation for Nanotechnology?

Three key questions will be considered in six breakout groups; each question will be addressed by two groups:

3. Which nanotechnology issues should include public input in decision making? Where does public input on nanotechnology issues have the best opportunity for influence?
4. How do we get the public heard in a bureaucracy? Who should be sponsoring public participation? Who should be listening? How do we get them to really listen?
5. Should nanotechnology be considered by itself or combined with other emerging technologies in a broader societal conversation?

5:00 – 5:30 PM Breakout Group B Reports

5:30 – 7:30 PM Reception

WEDNESDAY, MAY 31, 2006

8:00 AM Continental Breakfast

8:30 – 9:30 AM Panel 3. Engaging the Public in Science and Technology

Rob Semper, The Exploratorium

Overview of the challenges and strategies of engaging the public in current research such as nanotechnology, using exhibitions, media, programs, and other approaches. Panelists will share their experiences and lessons learned in public participation, followed by audience questions and discussion.

Larry Bell, Museum of Science, Boston

Carl Batt, Cornell University

Cynthia Needham, ICAN Productions

9:30 – 10:45 AM Participation-in-Action Presentations

Presenters will each provide a brief overview of a different approach to engaging the public in large, controversial topics.

Kathy Hudson, Johns Hopkins University, Berman Bioethics Institute

Genetic Town Halls

Tom Beierle, Ross & Associates

Online Democracy

Vence Bonham, Education and Community Involvement Branch, National Human Genome Research Institute, NIH

Community-Based Forums

Carolyn Lukensmeyer, America Speaks

21st Century Town Meetings

Chris Toumey, University of South Carolina

Citizens' Schools

Leslie Bourquin, Michigan State University

Extension Service Outreach

10:45 – 11:00 AM Break

11:00 – 11:45 AM Panel 4. Participation in Action Panel Discussion

11:45 – 1:15 PM Luncheon Speaker and Lunch

Presentation of research results of UK focus groups with various publics, conducted between 2004 and 2006. The research indicates a latent ambivalence toward nanotechnology and suggests potential concerns.

Phil Macnaghten, Lancaster University

Nanotechnology and "Upstream" Public Engagement in the UK

1:15 – 3:15 PM Breakout Groups C: How Should We Conduct Public Participation for Nanotechnology?

Three key questions will be considered in six breakout groups; two groups each will focus on one of the questions to identify what we know now, what we need to find out, and where we need to go next:

6. What does the public need to know about nanotechnology in order to meaningfully participate? How do we build in education as a component of nanotechnology public participation?
7. Is promoting open dialogue on nanotechnology enough? What types of processes and activities make sense for public input on nanotechnology?
8. How do we engage the unengaged? How do we move beyond the traditional special interests and really engage the general public? To what extent should we try?

3:15 – 3:30 PM Break

3:30 – 4:30 PM Breakout Group C Reports

Groups will each provide a 10-minute report on the key findings and recommendations for next steps on their respective questions.

4:30 – 4:50 PM Reflections Speakers

Several individuals, representing different sectors present at the workshop, will provide short reflections on the workshop and issues raised.

4:50 – 5:00 PM Wrap-up and Next Steps

Clayton Teague, NNCO

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APPENDIX C. GLOSSARY

AAAS	American Association for the Advancement of Science
CDCP	Centers for Disease Control and Prevention (DHHS)
CSREES	Cooperative State Research, Education, and Extension Service (USDA); as of 2008/9, it is called the National Institute of Food and Agriculture (NIFA)
DHHS	Department of Health and Human Services
EHS	Environment{al}, health, and safety
ELSI	Ethical, legal, and societal implications
EPA	Environmental Protection Agency
FDA	Food and Drug Administration (DHHS)
GM	Genetically modified
IAP2	International Association for Public Participation
NCDD	National Coalition for Dialogue and Deliberation
NCI	National Cancer Institute (NIH-DHHS)
NCDD	National Coalition for Dialogue and Deliberation
NHGRI	National Human Genome Research Institute (NIH)
NIOSH	National Institute for Occupational Safety and Health (Centers for Disease Control and Prevention/DHHS)
NIH	National Institutes of Health
NISE Net	Nanoscale Informal Science Education Network (NSF-supported)
NNCO	National Nanotechnology Coordination Office
NNI	National Nanotechnology Initiative
NPEC	Nanotechnology Public Engagement and Communications Working Group
NSEC	Nanoscale Science and Engineering Centers
NSET	Nanoscale Science, Engineering, and Technology Subcommittee of the NSTC
NSF	National Science Foundation
NSTC	National Science and Technology Council
USDA	United States Department of Agriculture

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