



Making Meaning Through Conversations about Science and Society

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Museums are changing the way they connect with their communities by positioning themselves as venues for engaging visitors in meaningful conversations about science and society. Part of this effort involves understanding the many factors that influence learning in a museum environment, including the values and life experiences visitors bring with them. By recognizing and incorporating visitors' own perspectives into their experiences at the museum and by fostering supportive social interactions, informal educators hope to make museum learning opportunities more effective (Ansbacher, 1999; Hein, 1999; Rounds, 1999). At the same time, scientific professional organizations are seeking to create dialogue among the public, scientists, engineers, and policy-makers in order to understand and solve a variety of pressing global and local issues.

In this article, we describe a large-scale, collaborative project to engage our museum communities—both staff and visitors—in meaningful conversations about the relevance of emerging technologies to our lives. The conversations are informed by and contribute to meaning-making theory in several ways: they apply visitors' own experiences and values to decisions about technologies; they validate visitors' opinions and identify a role for them in making decisions about emerging technologies; and they support learning as a social process. Here, we describe the goals of the project in terms of visitor learning and share strategies for effectively implementing conversations on the museum floor.

Project Background

The “Nano and Society” project is supported by the Nanoscale Informal Science Education Network (NISE Net) and the Center for Nanotechnology in Society at Arizona State University (CNS-ASU), and is funded by the National Science Foundation. The project involves over 50 organizations across the United States—including science museums, children's museums, and other informal learning organizations—that are part of the Network.

NISE Net is dedicated to fostering public awareness, engagement, and understanding of nanoscale science, engineering, and technology (or “nano” for short). The Network is led by a core group of 13 museums and universities, and includes hundreds of active partners across the country. Our exhibits, programs, and media are developed collaboratively, and are offered as open-source products available for free download from our website.

The overarching goal of the Nano and Society project is to empower museum educators and visitors to explore the relevance of nanotechnology to their lives. This is a departure from the majority of the Network's educational products, which focus on fundamental scientific concepts, tools, and processes related to nanotechnology rather than the implications of nanotechnology for visitors' lives (Kunz Kollman, 2011).

Nanotechnology is a relatively new, interdisciplinary field of research. At the nanoscale—the scale of atoms and molecules—many common materials exhibit unusual properties. Our ability



Educators at a Nano and Society workshop. They are learning a game where visitors prioritize the development of new nanotechnologies. Photo by Emily Maletz. Courtesy of the NISE Network.

to manipulate matter at this size enables innovations in materials and devices. While some new nanotechnologies and nanomaterials simply allow improvements to existing products (such as sunblock, golf clubs, and stain-resistant fabrics), others could be transformative.

Researchers are working on truly amazing ideas, including elevators to space, invisibility cloaks, and cures for cancer. If projects like these are successful, they could dramatically change our lives, in the same way that new technologies such as cars or computers have affected the way we live and work. Because nanotechnologies are still developing, as a society we can influence what they are and how they are used.

Conversations about Nano and Society provide participants with an opportunity to understand the relationship between technologies and society, to consider how emerging technologies will influence our lives, and to learn how we can shape the development of new technologies. In other words, Nano and Society conversations

support meaning-making by connecting with our values as individuals and the kind of collective future we want to build.

The Nano and Society project included a year of planning and development in 2011-2012, and was launched with a series of workshops and follow-up activities in 2012-2013. We were able to draw on expertise from many different organizations in the Network. The core project team included Arizona State University, Museum of Life and Science, the Museum of Science and Industry, the Oregon Museum of Science and Industry, the Science Museum of Minnesota, and the Sciencenter in Ithaca, NY.

Planning and development began in Fall of 2011, and involved a series of roundtable discussions with Network partners and several meetings with Network advisors. The development process included visitor evaluation, peer review, and scientist review of the educational and training materials, as well as a pilot workshop with

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museum professionals.

Deliverables included a set of key concepts for Nano and Society conversations, a variety of educational activities to serve as “conversation-starters,” and a suite of staff training materials. These materials can be downloaded from http://www.nisenet.org/catalog/tools_guides/nano_society_training_materials.

Implementation began in Fall-Winter of 2012. In September and October, around 100 informal educators representing 54 organizations participated in Nano and Society workshops held at the Children’s Museum of Houston, the Lawrence Hall of Science, the Oregon Museum of Science

and Industry, and the Science Museum of Minnesota. From October to December, workshop participants implemented Nano and Society conversations at their museums and used a team-based inquiry process to collect data and reflect on strategies for facilitating successful conversations. Participants shared and analyzed this information in a series of web conferences and a final in-person meeting.

Many partners are now expanding and intensifying the project locally. For example, some museums such as the Children’s Museum of Science and Technology in Troy, NY and Port Discovery Children’s Museum in



A surprising demonstration can spark a conversation. In this activity, visitors experiment with refraction, then talk about what would happen if invisibility cloaks existed. Photo by Emily Maletz. Courtesy of the NISE Network.

Baltimore are partnering with nearby universities to host Nano and Society conversations. Others, such as the Arkansas Museum of Discovery, have hosted training sessions to share the project with their own local networks of museums.

Visitors are Authorities

We identified two essential elements for a Nano and Society conversation: a focus on visitors' own values and experiences related to technologies and social relationships, and skillful facilitation by educators to help visitors apply these to bigger-picture decisions about future nanotechnologies that we face as a society. Successful conversations allow visitors to articulate ideas about the kind of future they want to live in, and the way that they think technologies will help or inhibit building that future.

Nano and Society conversations begin with a tangible activity or demonstration, which gives visitors and educators something to talk about. Three key concepts provide a conceptual framework for the conversations:

1. Values shape technologies.
2. Technologies affect social relationships.
3. Technologies work because they're part of systems.

For example, in the “Exploring Nano & Society—Invisibility” activity, educators do a quick science demonstration to spark visitors' curiosity about the potential for nanotechnology to make objects invisible. In this demonstration, visitors



Educators facilitate the meaning-making process. At this exhibit, visitors consider nanotechnologies as part of bigger social and technological systems. Photo by Emily Maletz. Courtesy of the NISE Network.

are surprised to discover a transparent borosilicate glass object hidden in a beaker of mineral oil. (The object can be hidden because it has a similar refractive index to the oil.) The educator explains that scientists in the field of nanotechnology are experimenting with ways of bending light to cloak objects, making them invisible to the human eye or to surveillance devices.

The educator can then initiate a conversation by asking what visitors would do if they had an invisibility cloak. Many children suggest mischievous activities, such as stealing cookies or spying on their friends. With this start, the conversation can delve into more weighty topics. The educator might ask if the child would want her parents or friends to spy on her using an invisibility cloak, leading to a discussion about privacy rights. Or the parent might ask what would happen if criminals had invisibility cloaks, turning the conversation to government regulation of technologies. Whichever way the conversation goes, the educator can ensure that it touches on one or more of the Nano and Society learning objectives. The educator can also help visitors find personal relevance and meaning by considering or expressing opinions on how nanotechnologies should develop.

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Conversations are social learning experiences. Here, a visitor imagines what kind of world we would create if we had an elevator to bring people and materials to outer space. Photo by Gary Hodges. Courtesy of the NISE Network.

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Educators are Facilitators

In Nano and Society conversations, the typical roles of the educator and the visitor shift. Visitors take on some authority by contributing essential expertise, namely their values and experiences related to technologies. Meanwhile, educators take on the role of facilitator rather than expert, asking questions, offering ideas or information to consider, and providing new perspectives. Educators guide a conversation by helping visitors reflect on and form their own ideas and opinions, in light of their values and established science.

As we have gained experience facilitating Nano and Society conversations,

Network educators have identified several fundamental strategies that appear to be helpful in encouraging meaningful conversations:

Set expectations. To initiate a conversation, ask questions or make observations about what visitors say and do. This validates visitors' perspectives and focuses the interaction on making meaning rather than imparting information.

Guide the conversation. Allow conversations to follow visitors' interests and respond to what is happening at the moment. At the same time, gently guide the conversation so that it draws out visitors' experiences and values related to technologies.

Use good communication skills. As the conversation progresses, listen to visitors and signal interest and encouragement through verbal and non-verbal cues.

Make connections. Suggest ways that the conversation might apply during the rest of their visit, or in everyday life, to help clarify the ideas and extend visitors' learning.

These facilitation strategies (and others) are part of an ongoing research study at the Science Museum of Minnesota. The study investigates ways to encourage visitors to form opinions and make decisions about nanotechnology. Preliminary results of the study support using a two-way, conversational approach, focusing on visitors' values and experiences, establishing relevance, and gradually building a conversation by

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introducing new perspectives and issues (Svarovsky, 2012).

Conversations are a Social Process

Conversations are a social learning experience that can include everyone in a visitor group. Children are often good at imagining future technologies that are very different from what we have today, while adults can often identify how those new technologies might change our lives in concrete ways.

For instance, the “Exploring Nano & Society—Space Elevator” activity asks visitors to imagine what would happen if new nanomaterials made it possible for us to build elevators into space. At a community science night, one young girl spent over half an hour meticulously drawing a picture of her space elevator, detailing how it would be powered, who could ride it, the route it would take through the solar system, training requirements for elevator staff, and the food they would serve on board.

In another example, one family group at the “Exploring Nano &

Society—Flying Cars” activity was busy building the fastest, most powerful toy cars they could imagine...until the father reminded his son of his fear of heights. This prompted the addition of seatbelts and an emergency parachute to the boy’s car, and encouraged a rich conversation around the hazards of air travel, safety regulations, law enforcement, and product testing.

In Nano and Society conversations, the “Oh, wow!” moment occurs when visitors think about the *people* that imagine, create, and decide to use technologies. They come to understand the role we all have in developing and adopting technologies, and the ways that those technologies affect our personal relationships and our society more broadly. And this, we find, is a powerful way to engage visitors in learning about nanotechnology: promoting interest and enjoyment, connecting science and engineering with society, and indicating some of the ways that new technologies may profoundly affect our lives. ✨

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