Nanotechnology and Society:

A Practical Guide to Engaging Museum Visitors in Conversations

By Jameson Wetmore, Ira Bennett, Ali Jackson, and Brad Herring

The Nanoscale Informal Science Education Network (NISE Net) is a national community of researchers and informal science educators dedicated to fostering public awareness, engagement, and understanding of nanoscale science, engineering, and technology. This guide was created as a collaboration of the NISE Net and the Center for Nanotechnology in Society at Arizona State University.

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Introduction

The Nano and Society project of the Nanoscale Informal Science Education Network (NISE Net) is designed to empower museum educators and visitors to explore the relevance of nanotechnology in our lives. The project builds upon the fundamental scientific concepts, tools, and processes related to nanotechnology that are central to many of NISE Net's other educational materials and programs. It then considers how new nanotechnologies may affect people and the societies they live in and create. These technologies will open up new possibilities, shape our relationships, promote the values of those who build them, and through a variety of systems affect many different parts of our society and communities. This project is different from many other museum programs because it seeks to encourage visitors not just to think about science and technology, but to participate in the conversation. To achieve this, it encourages conversations that can help museum guests think through what their values are, better understand how other people think about values, recognize the expertise they have, and increase their confidence to contribute to the broader discussion about these technologies. At its core, this project aims to illustrate that while new nanotechnologies will help shape our future, people everywhere have opportunities to influence what that future looks like.

This guide serves as a short introduction to how museum professionals can engage visitors in conversations about nanotechnology and society and help make our science centers a place where the future of nanotechnology is not just imagined, but shaped.

This guide introduces three big ideas in technology and society and illustrates them with related videos and hands-on activities. It then explores those big ideas in very brief case studies of three nano-specific technologies, providing further examples of conversations that might occur on a museum floor. Finally, the guide explores strategies and tips for engaging visitors in conversations as part of their learning experience. On the last three pages there is a list of additional resources that can help to put these ideas in action including educational products, training materials and videos, improvisation exercises, websites, and further reading.

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Technology and Society

We often think of science simply as "what we know about the natural world" and technologies as "only tools." But this knowledge and these tools can be incredibly powerful. Not only can they move mountains, send people to space, and enable communication with people all over the world, they can make it possible for families to live thousands of miles apart, spark a need for government regulations, and shift the balance of power between rich and poor. The decisions we make about science and technology have profound effects on people.

It may seem that science and technology are the domains of scientists and engineers—that you must understand the technical details in order to have any influence. And science and technology are completely intertwined with our social world—they influence society, but society also influences them. In order to ensure that science and technology have the biggest possible benefits, we need people who understand links between scientific facts, technological change, public welfare, and daily life to be part of the conversation. There are lots of scholars who think about and research the roles that science and technology play in our everyday lives. They study how people make decisions about the things they buy and use, how the government makes decisions about what research to fund and how to regulate new technologies. These scholars can play an important role in this process, but it is even more important to give everyday citizens a voice.

Technologies are techniques, machines, and systems designed to reorder the world to solve problems.

Why Science Museums?

Gary Hodges

Science and technology centers, children's museums, and other informal science learning organizations are increasingly finding ways to connect with our communities and make the experiences we offer relevant to visitors' lives. 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 and engaging. At the same time, scientific professional organizations seek to encourage dialogue among scientists, engineers, policymakers,and people everywhere in order to help understand and solve a variety of pressing global and local issues. As institutions that are trusted by all of these parties, museums provide an important venue for these conversations to take place.

The relationships we have with our communities are especially valuable for fostering conversations about emerging technologies. For instance, nanotechnology is poised to have a significant impact on our lives in the coming years, and as such it is very important that we engage in open conversations about what it is, what is possible, and where we would like it to go. But sometimes people's voices about science and technology are muted because it can be difficult to know how to engage in these discussions. Nanotechnology can be especially intimidating, as many people do not even know what it is.

Science centers can inform people about nanotechnology, help them begin to reflect on the possibilities, and foster conversations to give them practice engaging in discussion around nanotechnology. This guide serves as a short introduction to how museum professionals can engage visitors in conversations about nanotechnology and society and help make our science centers a place where the future of nanotechnology is not just imagined, but shaped.

Mini-drone: Ben Finio / Harvard Microrobotics Lab, Sunscreen: Emily Maletz, All other images: iStock

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Three Big Ideas in Technology and Society

This guide is focused on “three big ideas” that can provide a framework to help museum staff and visitors feel empowered to reflect on the relevance of nanotechnology in their lives through open-ended conversation.

These three ideas don’t necessarily provide clear answers about technology and society, but they can help us to better understand the implications of technology and formulate better questions about the role that technology plays in our lives today and in the future. These three ideas provide us with a way to think about the larger implications of technology, including nanotechnology.

VALUES

Values shape how technologies are both developed and adopted

RELATIONSHIPS

Technologies affect social relationships

SYSTEMS

Technologies work because they are part of larger systems

Values shape how technologies are both developed and adopted

Every time we make a decision about technology or science, we are making a values decision. When we choose what to study, what to buy, or how to use a technology we are deciding what is most important to our families, in our jobs, and for our communities. In this process—whether we are conscious of it or not—we look at the possibilities, reflect on our values, and then change the world—even if it is in a very small way.

NISE Net's "You Decide" game encourages conversations about values and technologies.

This is perhaps most easily seen in the decisions we make as consumers. When we buy technologies we are often motivated by our goals, hopes, and dreams. We buy a hammer because we want to fix our house without having to pay an expensive contractor. We buy a computer so that our children can be better prepared for school. And we buy a 1967 Alfa Romeo 1600 Duetto Spider sports car because we want to cruise along the beach with the wind in our hair. In each of these cases we have a set of values we want to advance, and we choose to use a technology to advance them.

Brad Herring / NISE Net

VIDEO To see one man's reflections on the ways in which agricultural technology impacts his values watch NISE Net's ***"Tomato Picker"*** video: www.vimeo.com/50530393

TRY THIS NISE Net's ***"You Decide"*** game is a great way to explore the ways values and technologies are intertwined. Throughout the game, players must make decisions about which future nanotechnologies to prioritize. Facilitators can ask questions to help players see how they use their values, and think about the values of others, in making decisions about technology. Download resources for the activity at: www.nisenet.org/catalog/programs/exploring_nano_society_-_you_decide

When we use technologies we also play a role in deciding which values are advanced and which ones are not. For instance, when we are worried about being late to work and drive 100 miles an hour to get there, we are prioritizing our time (and perhaps our reputation) over safety. When we handwrite a letter to a loved one rather than send an email, we prioritize being personable over being fast. Whether we choose to read a book or watch a movie depends on how we want to challenge our imagination.

Values also shape what scientists and engineers do. A combination of different values can motivate people to become scientists and engineers. They may do it because they find it fun. They may do it because they think they can make a lot of money at it. And they may do it because they hope to make the world a better place through innovation. Their work, in turn, has an impact on values—sometimes well beyond their knowledge.

Scientists, corporations, and funding organizations (like the US government) make incredibly powerful value decisions about science and technology when they decide what work to pursue. They may choose to prioritize research on diseases that are prevalent in the United States and other wealthy countries, or diseases that affect significantly more people in the developing world. They may decide to focus on developing medical technologies that help us live longer, or medical technologies that help us keep our independence later in life. And they may choose between developing technologies specifically for military use, or shifting funds and attention to solving domestic problems. As citizens, voters, and consumers we can exert some influence over these important decisions, especially when we recognize them as values decisions and not just technical decisions.

Unfortunately, making these decisions is not always easy because values are often in conflict. Sometimes different groups have different values—as when environmental groups prioritize protecting marine habitats and demand that ocean oil drilling be banned, while oil companies prioritize the nation's economy and argue that the ability for millions of Americans to drive to work depends on such drilling. We can also have conflicting values in ourselves. We would probably all like to get to work faster in the morning, but would also like to arrive safely. We must carefully think through our values as individuals and as larger communities to make better decisions about the technologies we research, buy, and use. Remembering that our values—and the values of others—are at stake in these decisions can help us make more informed decisions about technology.

Encouraging conversations helps us carefully think through our values as individuals and as larger communities to make better decisions about the technologies we research, buy, and use.

Technologies affect social relationships

Wikimedia

When we think of the impacts of technologies, we often focus on the technical details. A turbo diesel engine can make a car more fuel efficient. A new microchip can make a cell phone smaller. A fiber optic connection can make data transfer more reliable. But technologies also impact relationships between people. Sometimes these are small. When you buy a GPS system you are less likely to ask a friend or relative for directions. But sometimes they are much bigger. A hundred years ago, extended families tended to live close to each other—even in the same house. With the development of new transportation systems like airplanes and cars, coupled with instant communication systems like telephones, people can still feel connected to their families even if they live far away. Families in the United States now are often spread all across the country—a significant social change from the way life used to be.

Sometimes technologies are designed with the specific intention of impacting the relationship between people. Traffic lights tell drivers how to behave—and who has the right of way—when they arrive at an intersection. Wheelchairs help to reduce the divide between people with different walking abilities. Automated checkout machines eliminate our need to interact with grocery store clerks, and may ultimately result in grocery stores eliminating this position.

VIDEO See NISE Net's ***"Cell Phone Rules"*** video for additional discussion of the ways that technologies can impact relationships and the steps people take to promote the kinds of relationships they want with other people: www.vimeo.com/50530764

TRY THIS NISE Net's ***"Exploring Nano & Society—Invisibility"*** activity is a great way to help visitors think about how technologies can affect relationships. Most visitors are excited by the prospects of an invisibility cloak until they consider that other people might use it for purposes they dislike. They like the idea of being able to spy on others…but are not as excited about being spied upon. Often visitors will take the initiative and suggest regulations to increase the chances that the technology doesn't destroy our right to privacy: nisenet.org/catalog/programs/exploring_properties_-_invisibility_nanodays_2013

In the Invisibility Activity, visitors explore refraction, and discuss how their lives might be different with an invisibility cloak.

Thinking about how a technology changes our relationships with our parents, our significant others, our friends, our co-workers, and even people we've never met face-to-face can help illuminate the ways in which our society and technology are interlinked.

A technology like Facebook can impact relationships in a variety of ways. It can help us share information and stay connected and up to date with old friends. It can be used by companies to screen potential employees for potentially embarrassing personal lives. It can be used to communicate with people we have never even met face-to-face. And it can distract us from the people sitting next to us, perhaps harming our personal relationship with them.

Technologies impact all aspects of our society. Thinking about how a technology changes our relationships with our parents, our significant others, our friends, our co-workers, and even people we've never met face-to-face can help illuminate the ways in which our society and technology are interlinked. With this reflection we can choose technologies—and adapt the way we use them—to prioritize the types of relationships that we hold most dear.

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Technologies work because they are part of larger systems

It can be tempting to think that technologies are devoid of values because they are simply pieces of plastic or a tangle of circuits. But technologies don't work unless they are linked to larger systems. For instance, a cell phone does nothing without cell phone towers to relay messages, a power supply that can recharge a battery, and a company that routes the calls to the numbers dialed. Only when you look at the larger system you can see why the technology works. And by looking at that larger system you can also better see the impact that a technology might have on the world.

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A large, complex system makes it possible to buy inexpensive, ready -to-cook hamburgers in the supermarket.

Let's take a single carefully wrapped hamburger that you might buy at a grocery store as an example. It may seem a little odd to think of a hamburger as a technology, but it is a product of human ingenuity. It is the carefully crafted result of a large system that includes numerous people, technologies, institutions, and decisions. A farmer must raise the cow and decide what to feed it, whether to let it graze freely, and whether or not to treat it with antibiotics and growth hormones. A slaughterhouse must decide how to cut the meat, how to keep its equipment clean, whether to slaughter multiple animals together (risking contamination), and whether to take the extra steps to receive kosher or halal certification. A transportation company must decide how to move large amounts of meat around the

VIDEO

See NISE Net's ***"Light Switch"*** video to see how a technology we use every day is better understood as part of larger systems: www.vimeo.com/50538701

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TRY THIS

Robots are human-made machines designed to do a job. Once they are programed, robots work on their own. Many robots can sense and react to their surroundings, but they only function within a broader support system. NISE Net's ***"Robots & People"*** full-length program helps visitors explore what robots and nanobots are, what they can do, and how they might affect our lives. In the second part of the program, visitors imagine and draw a robot, designing it to do a particular task—a task which usually involves impacting another technological or social system. In discussing and imagining their own ideas, visitors consider the many factors that go into integrating a robotic innovation into our complex world. Download resources for the robot activity at: www.nisenet.org/catalog/programs/robots_people

Sciencenter

Visitors imagine and design their own future robots.

country as well as what steps it will take to keep the meat fresh. The United States Department of Agriculture must decide whether and how to certify the meat produced as fresh and safe to eat, how the hamburger should be labeled, and how it should be described in the food guide it produces to inform people's eating habits. And the grocery store must decide how to package it, how to display it, and how much to charge.

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Every step in the process of putting that hamburger in front of you involves important value judgments. By seeing the hamburger as part of a larger system you can observe all the different pieces and the values that go into it. By thinking through the larger system behind the technology you can decide how you want to be associated with it. Such a reflection can empower you as a consumer and as a citizen. When you buy a technology you become part of the systems around it.

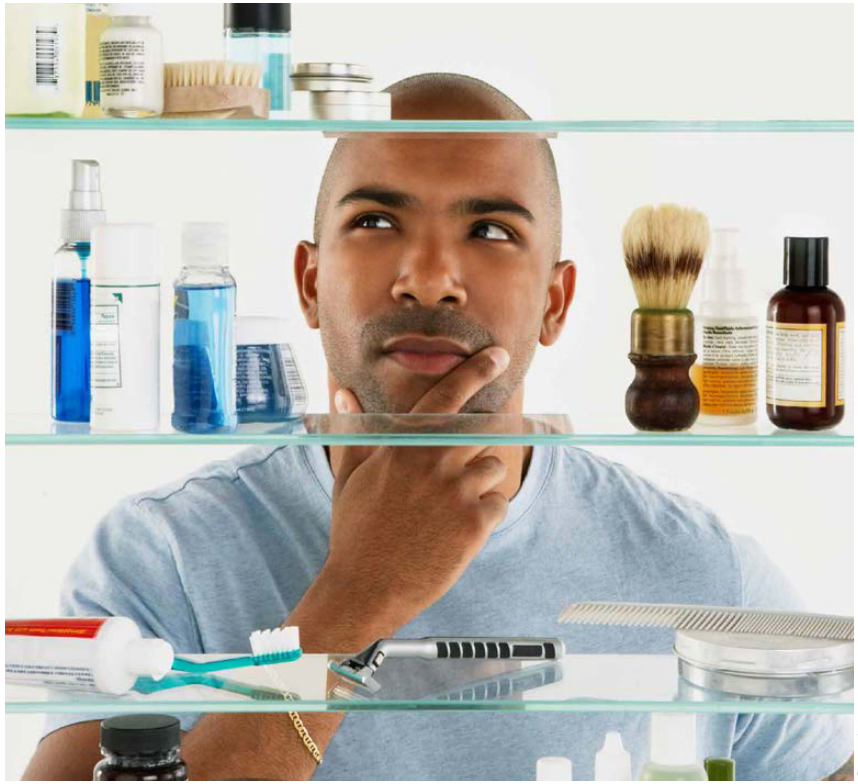
By looking at the systems that support a technology you can better see the impact that it might have on the world.

Nanotechnology and the Three Big Ideas

These three big ideas—values, relationships, and systems—are tools. They don't answer questions about technology and society, but they can help us to better understand the implications of technology and formulate better questions about the role that technology plays in our lives today and in the future. These three ideas provide us with a way to think about the larger implications of technology.

We offered the previous examples because they are all technologies and situations that we commonly encounter. Nanotechnology is a bit more foreign to many of us, which can make it a bit more challenging to apply the big ideas to nanotechnologies. But it presents an important opportunity. Once technologies are built and integrated into society they can be difficult to change. Think about how difficult efforts have been to shift from gasoline-powered automobiles to electric vehicles. Because many nanotechnologies have not yet been built, or at least are not that common, there is an opportunity for many more people to have an impact on what those technologies look like and how they are used. We as individuals may only be able to directly affect our own decisions and those we care for. But even these changes can add up and if we work to have our voices heard we may be able to contribute to broader conversations as well.

These three ideas—values, relationships, systems—provide us with a way to think about the larger implications of technology, including nanotechnology.



Getty Images

Many consumer products such as lotions, skin creams, and sunscreen already contain nanoparticles.

This section offers three very brief case studies of nano-enabled technologies that have already been developed or are in the process of being developed. Because none of them are yet entirely commonplace, there are still opportunities for shaping how they are built and used. The three big ideas are applied in each case to help us to begin to see some of the possible implications of the technologies.

Nanosilver socks

Nanosilver socks are one of the most widespread nanotechnology products available. They are just like normal socks except that they have silver nanoparticles embedded in their threads. The nanoparticles act as an antibiotic agent, killing bacteria and fungus on the wearer's feet. This can help keep foot odor from occurring as well as provide protection against infection for people with circulation issues or compromised immune systems. Researchers have shown that the silver nanoparticles can wash out of the socks over time, allowing the particles to enter the wastewater stream. Scientists are still trying to determine the impact of nanoparticles on the wastewater treatment system and what happens after they leave the wastewater system.

VALUES We know that nanosilver socks have benefits that range from protection against disease for soldiers and diabetics to better-smelling used gym clothes. But we don't yet know what effect silver nanoparticles will have on our environment. How do we want to balance known benefits with not yet understood risks?

RELATIONSHIPS It is generally agreed that a decrease in foot odor improves relationships between individuals who are around each other. But nanosilver socks may have a different impacts on different groups of people in a community. If disposal of the socks has a negative impact on the environment, then those who live near or downstream of waste facilities may suffer more negative health outcomes than those who live in more affluent areas.

SYSTEMS We tend to only think of socks when they are on our feet, but they have to be made, washed, and disposed. With nanosilver socks in particular, the introduction of new materials into the wastewater treatment system can be risky because many municipal wastewater facilities rely on bacteria to break down waste. We don't completely understand how these particles will affect the system. What level of precaution should we take with the disposal of nanosilver products?

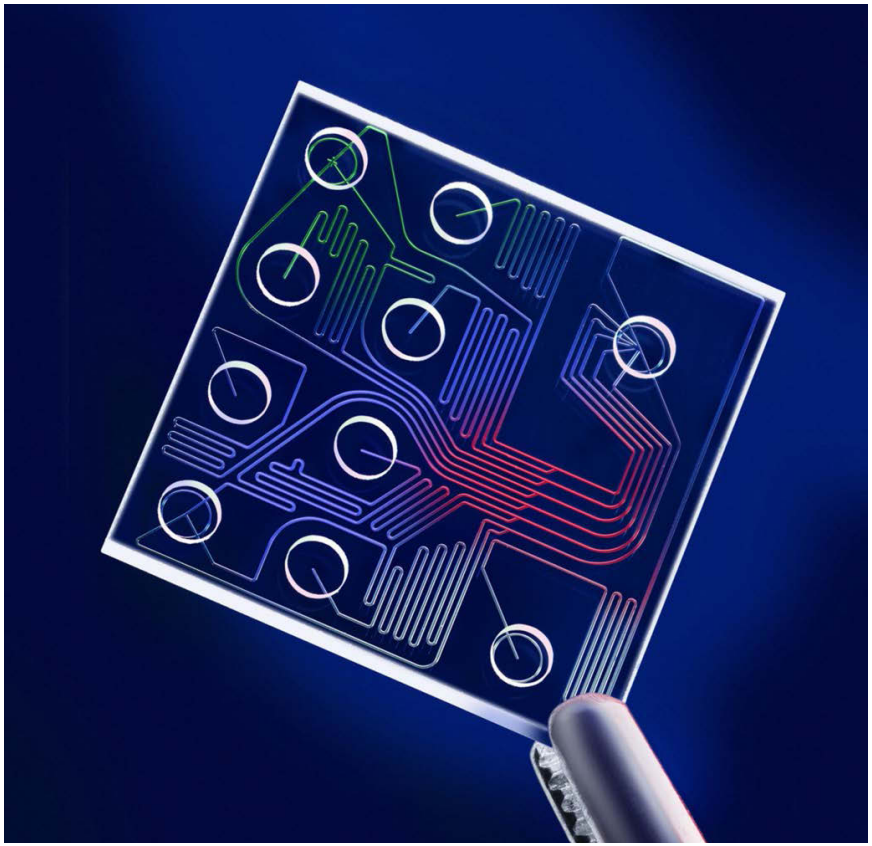
Nanosilver, like that found in these socks, is one of the most common nanomaterials found in consumer products.

Lab-on-a-chip

A number of researchers are currently working to develop what they call a "lab-on-a-chip." These small devices will be able to take one of your body fluids (like blood or saliva) and analyze it to determine whether you are likely to develop specific diseases or health conditions, without ever visiting a doctor. One way this might work is that every day at breakfast you would breathe into a straw and the chip would see if your susceptibility for any problems or exposures to dangerous chemicals has increased. Such daily monitoring might help to find future conditions very early and perhaps make treatments more successful. Some of these devices are currently available, but scientists are working to make even smaller designs that can screen for many more diseases with a faster response time.

VALUES What diseases do we want our chips to diagnose? It may be tempting to say that we want to know everything, but do we want to know that we suffer from a disease that has no cure? Labs-on-a-chip might do an amazing job at diagnosing diseases in wealthy countries. But they may be too expensive to be easily distributed to everyone. How should governments and scientists invest time and resources to further worldwide health?

RELATIONSHIPS At-home diagnostic technologies would likely reduce our need to interact with human doctors and nurses. These professionals are specially trained to tell when a diagnosis causes someone stress, offer them emotional support, and help them to deal with the problem. How can we balance new technologies and emotional support to best deal with disease?



Courtesy of Agilent

Nanotechnology may make it faster and easier to detect disease.

SYSTEMS The chip won't work by itself—it will have to be patched into a computer that can process the data. Someone, most likely a corporation in this case, will have to build a database that can translate the data into a usable form. And ultimately the lab-on-a-chip doesn't do much good unless there is a medical system that can cure the disease, alleviate the symptoms, or address the problem. How do we want this data to be used and distributed?

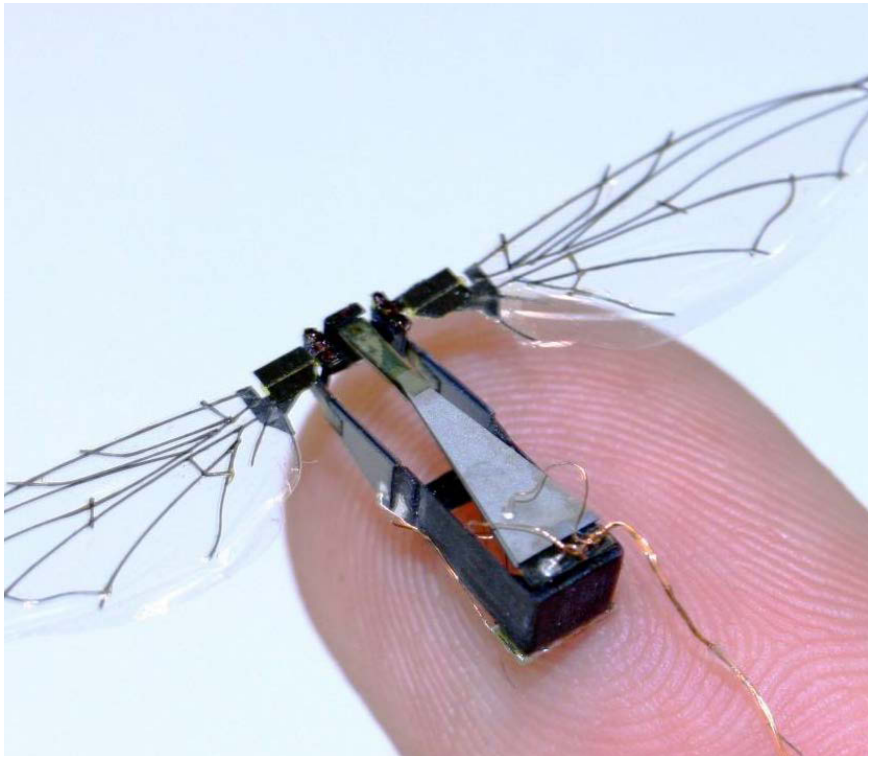
Mini-drones

There is currently a major push in nanotechnology to create electronic devices that are even smaller and more powerful than those we have today. One of the proposed benefits of such scaling down is the possibility of building incredibly tiny drones that could fly almost undetected through the air and collect data (including images) of people and places without their knowledge. This research is motivated by a desire to decrease the chances and impacts of terrorist attacks, but surveillance technologies are currently being employed by many people outside of the military as well.

VALUES These devices will inevitably reduce people's privacy. What is the balance between personal privacy and public safety that we are happiest with?

RELATIONSHIPS Very likely, drones will primarily be used by police forces and the military. But many technologies originally designed for government use, have also been developed for civilian use. There is nothing immoral or illegal about singing in the shower. But if surveillance was placed inside our bathrooms, most of us would probably be less likely to sing. Would our friends, bosses, or parents be interested in knowing this information about us, and if so, would they treat us differently as a result? How might our relationships change if we knew we might be watched at any moment?

SYSTEMS Mini-drones will not be independent. They will be used by specific people for specific purposes who will collect information and then send it to others. Thinking about the complex systems needed to support this technology helps us see that there are many value decisions that must be made. For instance, will spying be a practice available to anyone or will it be limited in some way? Should the information gathered by drones be available to everyone, to police officers, or only to special government agencies? If we think some limits are important, how should they be decided and enforced?



Ben Finio / Harvard Microrobotics Lab

Surveillance drones are becoming smaller, thanks to the use of nanotechnology.

Because many nanotechnologies are not yet common, there are still opportunities for shaping how they will be built and used.

Museum Conversations

We of course engage in conversations all the time—about what we should have for dinner, how we should get to work, and what we should study in school. Our museums have an opportunity to expand those conversations to include deeper understandings of science and technology. Successful conversations encourage visitors to reflect on the kind of future they want to live in and envision the ways that technologies will help or inhibit building that future. These three "big ideas" of technology and society help underscore the interconnections between our everyday lives and the development and adoption of new nanotechnology. Turning these ideas into conversations helps us think about them much more personally and powerfully. Conversations help visitors relate nanotechnology to their own lives, recognize the important role that values play in technological decisions, and see the roles they can play in the broader discussions about nanotechnology. Using such an approach in the museum supports learning as a social process.

The NISE Net has focused its approach to engaging people in nano and society around encouraging dialogue and conversation between educators and visitors. We recognize that every visitor comes to our programs with their own unique and valuable experience to share. Conversations can provide a space for visitors to not only share their ideas, but to rethink them and build on them with new facts and ideas from others.

Two Approaches to Engaging Visitors

Demonstration:

- Scientist/educator has knowledge and expertise to share
- Visitors discover phenomena and laws of nature
- Facilitator communicates facts
- Visitors ask questions and receive answers
- Promotes basic goal of public understanding

Conversation:

- Everyone has their own values and perspectives to share
- Facilitators and visitors consider facts and values
- Facilitators and visitors ask questions and receive responses
- Visitors form opinions and explore ideas
- Promotes basic goal of public engagement

In the context of a conversation, the role of the educator and the visitor is somewhat different from a typical museum demonstration. For instance, in order for conversations to work, visitors must take on a very active role. They must recognize that their experiences and values can help to inform the discussion and be willing to share their ideas. Because visitors may be more comfortable as passive receivers of knowledge, educators must take on the role of a facilitator. Educators may initiate and encourage dialogue by asking questions, offering new ideas or information to consider, and providing different perspectives. Educators can guide a conversation by helping visitors reflect on and form their own ideas and opinions, taking into account their values and established science. Facilitators can help visitors recognize that they are experts in their own values, and therefore have something important to contribute to shaping the future of science and technology.

Goals for engaging visitors in conversations:

- Educators and visitors participate in open-ended, engaging conversation.
- Educators and visitors have distinct, equally important roles in the conversation.
- Participating in a conversation is a meaningful learning experience for visitors and educators.
- Facilitating a conversation is a valuable interpretative method for educators.

What does a good conversation look like?

One common thing visitors say as they approach a Nano and Society activity is, “What do you have here?” Like other museum experiences, they’re expecting the museum educator to show them something, perhaps give them instructions to try something, and finally to wrap everything up with an explanation. If the educator can immediately turn that interaction into a question rather than showing something or providing instructions, they can change the dynamic between and the expectations of the roles of both the facilitator and the visitor. At this point, the educator’s role as facilitator is to help visitors articulate their own unique perspective and work through their thought process. Visitors should feel the conversation provides them with insight into the relationship between nanotechnology and society and their role as a decision-maker with regard to technologies. Ultimately, educators can help people feel empowered to make and contribute to decisions about new and emerging technologies. In a successfully facilitated conversation, visitors will walk away with an understanding of one or more of the “big ideas” of technology and society, will feel like they’ve had an enjoyable experience, and will be able to connect the experience to their own lives.

Engaging visitors in conversation

Conversations often happen naturally in our organizations, but there are steps we can practice to help facilitate them and make them richer. Everyone has their own techniques for generating conversations. What comes easily to one person may not work for another person. Taking time to practice conversations with other professionals, reflect on your own values and experiences, and discuss these ideas with family and friends are good ways to get

comfortable with this approach. Conversations allow visitors to articulate ideas about the kind of future they want to live in, and the way that they think technologies might or might not be part of building that future.

Nano and society conversations don't have a place in every program, but as museum staff become more comfortable with these topics and the conversational approach, such engagements will begin to happen naturally on the floor. Remember, every crowd is different. Some groups may share their ideas with little prodding, others will be happy to engage when asked a few probing questions, and some may not want to engage at all, and that's okay.

Museum conversations can help visitors see links between their values and the technological systems they encounter and encourage them to think about where we are and where we want to go as a society.

Tips for encouraging meaningful conversations

GREET VISITORS Say "hello," make eye contact, and smile. Simply looking like you're available and friendly will invite visitors to interact with you.

LET VISITORS DO THE TALKING As much as possible, let visitors' interests guide the conversation. You can help them reflect on their own ideas and form their own opinions.

KEEP THE CONVERSATION OPEN-ENDED In a conversation about individual values and perspectives, there's no right and wrong answer. Your contributions can provide interesting things to think about, but shouldn't suggest a conclusion.

ASK QUESTIONS Help visitors reflect on their statements and assumptions by asking questions like: "That's an interesting idea, why do you think that?" "Have you thought about..?" "What would you say to someone who privileged this value instead?"

PAY ATTENTION TO YOUR AUDIENCE You may need to adjust the level of your conversation and questions depending on the age of your audience. Different activities work better for younger or older groups.

BE A GOOD LISTENER Be interested in what visitors tell you, and let their curiosity and responses drive your conversation forward.

MAKE CONNECTIONS Suggest ways that the ideas you discuss might apply during the rest of their visit, or in everyday life, to help clarify them and extend visitors' learning.

SHARE ACCURATE INFORMATION Scientific and historical facts can go a long way to inform a conversation about the future of nanotechnology. If you know details that can add to the conversation, feel free to introduce them. If visitors press you for information you just aren't sure about, it's OK to say, "I don't know. That's a great question!" Suggest that visitors go to ***whatisnano.org*** to learn more about nanoscale science, engineering, and technology.

REMAIN POSITIVE THROUGHOUT THE INTERACTION Keep things upbeat and positive. Remember that nonverbal communication is important too. Maintain an inviting face and body language.

USE GOOD COMMUNICATION SKILLS As the conversation progresses, listen to visitors and signal interest and encouragement through verbal and nonverbal cues.

STAY NEUTRAL Rather than taking a position yourself, offer examples of opinions different people might have. Question ideas, not individual people. Remember to keep your body language—as well as words—open and neutral.

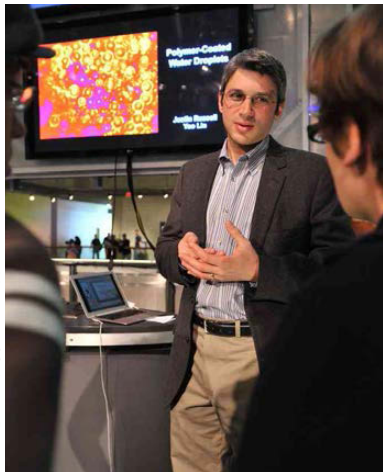
LEARN SOMETHING If you aren't learning anything from the conversations you are having with guests then you probably aren't doing it right. Make sure to listen. At the very least you'll learn more about the opinions people have about emerging technologies and how they think through problems.

DON'T FORCE IT A conversation should be a friendly exploration of ideas, and should last only as long as people are interested and positive about it. The most important thing is for visitors to enjoy their experience and begin reflecting—not to reach a conclusion.

THANK VISITORS Wrap up the conversation whenever it has run its course. A brief interaction is fine and may still be the thing they remember most from their day!

Conclusion

Introducing both the nanotechnology and society content and a more conversational approach into your museum at the same time can seem a bit overwhelming. But they can work hand-in-hand and play to your strengths. You don't have to know everything about nanotechnology or nanotechnology and society to have these conversations, and you don't have to teach a lesson. You can lead with the way nanotechnology is a part of our everyday lives as consumers and users of new technologies, and then expand from there. Thinking about how nanotechnology impacts your own life can help you to prepare for conversations you facilitate.



Museum of Science, Boston

Science museums have a long tradition of helping the public understand the latest scientific findings. With nanotechnology there is an opportunity to engage people in discussions about the future of science and technology. With a bit of guidance in seeing the links between technology and society, visitors can begin to reflect on the world that we are creating. Conversations on the museum floor can be the first step towards a broader public dialogue about the future of nanotechnology and can help to improve the chances that public good can be maximized.

This project is different from many other museum programs because it seeks to encourage visitors not just to think about science and technology, but to play an important role in them.

Additional Resources

Nano & Society Workshop Materials

NISE Net developed a number of materials for a series of workshops on Nano & Society held in fall 2012. Many of these materials can help you learn more about the topic and provide assistance with programs on the museum floor.

www.nisenet.org/community/events/other/nano_society_workshop

EDUCATIONAL PRODUCTS: *These programs focus on introducing Nano & Society to a wide range of age groups. Everything you need to get them up and running is available from the NISE Net catalog.*

- **Nano & Society—Flying Cars:** www.nisenet.org/catalog/programs/exploring_nano_society_-_flying_cars
- **Nano & Society—Invisibility Cloak:** www.nisenet.org/catalog/programs/exploring_nano_society_-_invisibility_cloak
- **Nano & Society—Space Elevator:** www.nisenet.org/catalog/programs/exploring_nano_society_-_space_elevator
- **Nano & Society—Tippy Table:** www.nisenet.org/catalog/programs/exploring_nano_society_-_tippy_table
- **Nano & Society—You Decide!:** www.nisenet.org/catalog/programs/exploring_nano_society_-_you_decide
- **Nano Around the World card game:** www.nisenet.org/catalog/programs/nano_around_world
- **Nano Exhibit Worksheet (for visiting school groups):** www.nisenet.org/catalog/exhibits/nano_mini-exhibition
- **Robots & People program:** www.nisenet.org/catalog/programs/robots_people

TRAINING RESOURCES: *If you are interested in providing your staff with training, specifically on nano and society, these materials can be adapted to different formats and time lengths.*

www.nisenet.org/catalog/tools_guides/nano_society_training_materials

- **Sample training agendas**
- **Training presentation slides**
- **Nano Around the World card game**
- **Big Ideas guide - Tips for Visitor Conversations - Conversation Goals**
- **Training video guides**
- **Team-Based Inquiry materials**

TEAM-BASED INQUIRY MATERIALS: *The NISE Net has found that using a process of team-based inquiry can help build evaluation capacity and improve products and educational experiences. In particular, team-based inquiry can help floor staff practice and become more comfortable with conversations.*

- **Team-based inquiry: A practical guide for using evaluation to improve informal education experiences:** www.nisenet.org/catalog/tools_guides/team-based_inquiry_guide

IMPROV EXERCISES: *NISE Net has found that improvisation exercises can go a long way towards building team unity and offers a way to practice conversations. These exercises can give even the uninitiated simple ways to introduce improvisation to museum staff.*

www.nisenet.org/catalog/tools_guides/improv_exercises

- **Leading Improv Exercises guide**
- **13 improv exercises guides**

TRAINING VIDEOS: *These videos replicate many of the lessons covered during the Nano & Society Workshops, but can also be used as training to reinforce certain messages.*

- **Three Big Ideas video:** www.vimeo.com/50530321
- **Tomato Picker video:** www.vimeo.com/50530393
- **Cell Phone Rules video:** www.vimeo.com/50530764
- **Light Switch video:** www.vimeo.com/50538701
- **Speed Bump video:** www.vimeo.com/50530523
- **Decisions in Innovation Systems video:** www.vimeo.com/50531422
- **Decisions in Personal Lives video:** www.vimeo.com/50532883

Additional Nano and Society Activities

These additional programs and videos from the NISE Net Catalog help introduce Nano & Society to a variety of audiences.

PRODUCTS:

- **Would you buy that?:** www.nisenet.org/catalog/programs/would_you_buy_nanodays_2014
- **Nano and Society Posters:** www.nisenet.org/catalog/media/nano_society_posters
- **Same Sides and Let's Talk About It:** www.nisenet.org/catalog/programs/same_sides_lets_talk_about_it

PUBLIC FORUMS:

- **Nanomedicine and Healthcare:** www.nisenet.org/catalog/forums/nanomedicine_healthcare
- **Energy Challenges, Nanotech Solutions?:** www.nisenet.org/catalog/forums/energy-challenges-nanotech-solutions
- **Privacy:** www.nisenet.org/catalog/forums/privacy_civil_liberties_nanotechnology
- **Risks, Benefits and Who Decides?:** www.nisenet.org/catalog/forums/risks-benefits-who-decides
- **Cognitive Enhancement:** www.nisenet.org/catalog/forums/cognitive_enhancement_teen_role_play_forum

VIDEOS:

- **Speeducate training video & worksheet:** www.nisenet.org/catalog/media/speed-ucate_video_or_how_have_effective_science_society_conversation
- **Three Angry Scientists:** www.nisenet.org/catalog/media/three_angry_scientists
- **Invisibility Cloak:** www.nisenet.org/catalog/media/invisibility_cloak
- **Does Every Silver Lining Have a Cloud?:** www.nisenet.org/catalog/media/does_every_silver_lining_have_cloud
- **Wonders and Worries of Nanotechnology**
  - **Regulation:** www.nisenet.org/catalog/media/wonders_worries_nanotechnology_regulation
  - **Ask and Research:** www.nisenet.org/catalog/media/wonders_worries_nanotechnology_ask_research
  - **Who Benefits:** www.nisenet.org/catalog/media/wonders_worries_nanotechnology_who_benefits
  - **Wonders and Worries:** www.nisenet.org/catalog/media/wonders_worries_nanotechnology

Additional Websites

- **Nanoquestions: an FAQ for nanotechnology (CNS-ASU):** www.cns.asu.edu/nanoquestions
- **The Project on Emerging Nanotechnologies:** www.nanotechproject.org/
- **Nano and me: Nanotechnology in our lives:** www.nanoandme.org/home/
- **University of Michigan Risk Science Center:** www.sph.umich.edu/riskcenter/

Further Reading

Deborah G. Johnson and Jameson M. Wetmore, eds: *Technology and Society: Building Our Sociotechnical Future.*
The MIT Press: Cambridge, Massachusetts, and London, England, 2009.
www.mitpress.mit.edu/books/technology-and-society