NISE network
NANOSCALE INFORMAL SCIENCE EDUCATION

Leading and Managing the NISE Network:

Practical Solutions for Creating a Flexible National Network

By Larry Bell and Vrylena Olney

What has your involvement in the NISE Network meant to you?

I am not alone! NISE Net has connected me with colleagues, given me professional development & collaboration opportunities, & reminded me that I & my tiny institution are part of something much bigger. Thank you!

ACCESSING A FANTASTIC BRAIN TRUST (can it come)

Resources that Gave us our Start

Being a small museum with the resources of a BIG museum

LEARNING FROM COLLEAGES

Professional Development

Finally being able to explain what we do to my Kids, neighbors, + Community.

... incredibly effective ...gues

JOY⁹

OPENING THE EYES OF THOUSANDS OF FOLKS TO NANO!

Learning from one another. Sharing experiences. Growing together. HAVING FUN!

Everything... ste... Collaborations · Hands... Professional Dev. · Happy... Fun science · Lasting rela... Wow! ·Outreach · Mini Exhibition...

Meeting fellow informal educators and exchanging ideas and resources.

Knowledge & Collaboration!

An opportunity to grow as an educator and museum professional

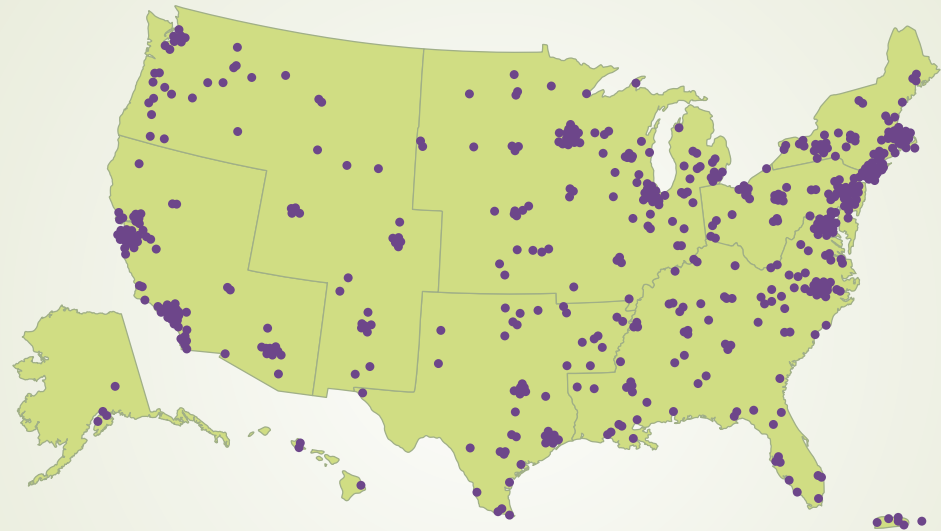NEW OPPORTUNITIES TO LEARN + SHARE :)

an Adventure

The NISE Network

The Nanoscale Informal Science Education Network (NISE Net) created a national community of researchers and informal science educators dedicated to fostering public awareness, engagement, and understanding of nanoscale science, engineering, and technology ("nano"). The goals of the original NISE Net project were to create a national community of partners to engage the public in learning about nano, to develop and distribute educational experiences that raise public awareness and understanding of nano, and to generate knowledge about public and professional learning through evaluation and research.
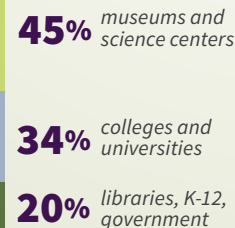
Continuing beyond its initial funding, NISE Net includes more than 600 museums, universities, and other organizations. The Network is organized into regions, each with a Regional Hub Leader that serves as the primary point of contact and provides advice, encouragement, and support to partners. Network partners work together to engage the public in new topics related to science, engineering, and technology. Collectively, our efforts give the Network broad reach to diverse public audiences across the United States.

The Network develops its educational products collaboratively, taking advantage of the talents

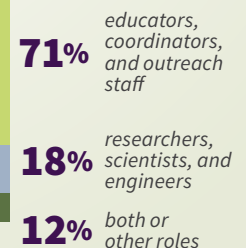NISE Net created a network of over

600 ORGANIZATIONS

that regularly participate in Network activities

600+ partner institutions

- **45%** museums and science centers
- **34%** colleges and universities
- **20%** libraries, K-12, government

2,700+ professionals

- **71%** educators, coordinators, and outreach staff
- **18%** researchers, scientists, and engineers
- **12%** both or other roles

of educators and experts from science museums and research institutions across the country. Our development process includes peer review by educators, prototyping and testing with the target audience, and review by scientists and other experts. The resulting programs are used by museums, universities, and other organizations across the country. NISE Net's educational materials are designed to engage a wide range of audiences in learning about complex scientific content in ways that are fun and easy to understand. Our website, *www.nisenet.org*, offers hundreds of open-source educational resources designed for different educational contexts to engage diverse target audiences, and conveys a range of content.

Throughout the 11½ years of NSF funding, NISE Net workgroups and leaders produced a variety of research and evaluation reports and practical guides detailing how different aspects of the work were carried out. All of these are available for free on *www.nisenet.org*.

After its success with nanoscale science, engineering, and technology, NISE Net has now expanded its scope to include a wide array of other STEM content areas related to current research, and has changed its name to the National Informal STEM Education Network, while keeping the NISE Network acronym.

About this Guide

This document was created to share what the leadership of the NISE Net did to create this national supportive network whose scope and scale were unprecedented in the science museum field. It focuses on 1) enduring values upon which the Network was built, 2) ongoing changes in structure and activities that were essential to developing the Network's capacity, and 3) some of the practical processes and

tools used to run the Network. We hope this information will be useful to others launching and managing future networks or large-scale collaborative projects.

In 2016, NISE Net transitioned to an ongoing identity as the **National Informal STEM Education Network,** leveraging the investment of the National Science Foundation for new projects and collaborations.

Contents

Foreword

by Larry Bell, Paul Martin, and Rob Semper

Despite our collective years in the science museum field, the NISE Net project was not like anything we had done before. It occupied 12 years of our lives, and while there were times that were very challenging, the project was extremely rewarding. That reward was made evident when the team of staff from funded partner organizations started to take on the work of the project at the very first organizational meeting, applying their own diverse knowledge, skills, values, and perspectives with a sense of commitment and enthusiasm for this unusual and even outrageous undertaking.

The reward became even greater a few years later when we saw the same kind of enthusiasm from the larger field composed of hundreds of professionals in the science museum, children's museum, and university research center and outreach communities. They told us how much they valued being involved and how the experience had changed their institutions as well as their own work and careers. We were blown away.

A lot of people were involved in making the project a success, from the development of the initial proposal to the writing of the final evaluation reports. Because of their involvement in leadership, management, and running the Network, some key folks to mention here include the team that developed the concept at the very start: Larry Bell and Carol Lynn Alpert (Museum of Science); Rob Semper, Tom Rockwell, and Bronwyn Bevan (Exploratorium); and Paul Martin (Science Museum of Minnesota). Many of our initial subawardee partners also helped us with launching the project, including talented people from the Sciencenter in Ithaca, the Oregon Museum of Science and Industry (OMSI), the New York Hall of Science, the Fort Worth Museum of Science and History,

the Museum of Life and Science, Cornell University, the Association of Science-Technology Centers (ASTC), the Materials Research Society, the University of Wisconsin-Madison, Purdue University, Inverness Research Associates, and Multimedia Research. Others later joined the project from The Franklin Institute, UC Berkeley's Lawrence Hall of Science, the Children's Museum of Houston, and SRI International.

Over the years, several people have played central leadership and management roles: Catherine McCarthy (Sciencenter, Science Museum of Minnesota) and Rae Ostman (Sciencenter, Science Museum of Minnesota, Arizona State University); Brad Herring (Museum of Life and Science); Vrylena Olney, Elizabeth Kunz Kollmann, Kayla Berry, Christine Reich, Andrea Durham, and Eli Bossin (Museum of Science); Sue Koch and Karen Pollard (Science Museum of Minnesota); and Kate Duckworth (Exploratorium). In addition to these folks, a variety of others led workgroups at various times over the decade. These include: Ali Jackson (Sciencenter); Veronica Garcia-Luis and Sherry Hsi (Exploratorium); Kirsten Ellenbogen, Stephen Guberman, Marjorie Bequette, and Sarah Cohn (Science Museum of Minnesota); Laura Huerta-Migus and Margaret Glass (ASTC); and Marcie Benne and Scott Pattison (OMSI). Additional people served as Regional Hub Leaders connecting hundreds of organizations to the rest of the Network: Christina Leavell, Sue Koch, and Karen Pollard (Science Museum of Minnesota); Jayatri Das (Franklin Institute); Frank Kusiak, Darrell Porcello, and Rashmi Nanjundaswamy (Lawrence Hall of Science); Vicki Coats and Tim Hecox (OMSI); Keith Ostfeld, Aaron Guerrero, and Kevin Velasquez (Children's Museum of Houston); Aaron Pan (Fort Worth Museum of Science and History); and others already mentioned above.

This report and guide is about the work of all of these people and many others who have helped make the NISE Net a success.

Preface

by David A. Ucko, Museums + more LLC

Not long after arriving at the National Science Foundation (NSF), I had the opportunity to draft language for a new Nanoscale Science and Engineering Education (NSEE) program solicitation. At that time, federal appropriations in support of the National Nanotechnology Initiative (NNI) made "nano" a hot topic at NSF. But Program Officers in the research directorates were concerned about possible backlash due to public fear triggered by Eric Drexler's "grey goo," Michael Crichton's novel *Prey,* or worse, an industrial accident. As a result, Mike Roco, who had proposed the NNI and spearheaded its efforts at NSF as Senior Advisor for Nanotechnology, approached the Informal Science Education (ISE) program about collaborating on preemptive action that might increase public awareness and understanding in a more positive way. Subsequent conversations led to a planning workshop that resulted in the FY 2005 NSEE solicitation.

The extent of such cross-directorate collaboration was unprecedented. Prior to that time, the ISE program was occasionally able to extract modest amounts of co-funding for its grants from the research side of NSF. Yet here was a desire to initiate funding and to do so at a scale unheard of for ISE. Funding was to be $20 million over five years, with approximately two-thirds coming from the research directorates. (After ISE, the Engineering Directorate contributed the most, followed by Mathematical & Physical Sciences, Biological Sciences, Computer & Information Science & Engineering, and Geosciences.)

My goal was to position this opportunity in ways that could best offer the potential to advance the informal learning field. Through its focus on an emerging area of research, the project could begin to address the challenge of how to present current science and technology. To do so effectively would require the collaboration of science centers, which could bring staff having expertise in informal learning and public audiences, together with practicing scientists and engineers, who could bring research knowledge and experience. To discourage the tendency of science centers to "reinvent the wheel" at each institution would also require fostering collaboration across participating science centers in developing exhibits, programs, and other resources that could be widely shared and adapted. These two modes of collaboration became the foundation for the solicitation's call for a Nanoscale Informal Science Education (NISE) Network that would create a national infrastructure linking science centers to each other and to researchers in their region.

The Museum of Science, the Science Museum of Minnesota, and the Exploratorium submitted the successful proposal, and I served as Program Officer for the resulting cooperative agreement. It took several years for the Network to take on a life of its own, rather than organize work into separate institutional "strands." The resulting Network infused transformative practices into the field at a scale beyond anything previously seen. Deliverables were developed by staff from different science centers working closely together, taking advantage of front-end research, formative evaluation, and peer review. This collaboration created the added benefit of professional development, especially valuable for staff from smaller institutions. The products developed were open source, and disseminated to the greatest extent possible by means of an online catalog. A special event (NanoDays) enabled the expanding Network to create an annual focus that leveraged its collective resources on a national and international scale. Forums engaging audiences in the societal impact of the emerging technology became an important new kind

of public program. Team-based inquiry was introduced as a tool for data-based decision making, supporting evaluation and research as components integral to the development process.

NISE Net has exceeded my most ambitious expectations. The Network has formed an active professional community representing some 600 partners drawn from colleges and universities, industry, schools, and community organizations, along with science centers and museums. Through their collaborative efforts, hundreds of products have brought awareness and knowledge of cutting-edge science and technology to tens of millions of children and adults in every state, as well as overseas. Perhaps most significant have been its transformational effects on practitioners, institutions, and the field at large.

NISE Net offers a new organizational and programmatic model with potential to continue to build and extend the capacity of the informal learning field. This innovative model could be applied to other topics, encompass additional categories of partners and venues, and create different kinds of products. Fortunately, ways have been found to sustain at least critical elements of the NISE Net infrastructure established through the 10-year $41 million NSF investment. In addition, the knowledge gained and effective practices developed over that period should provide invaluable guidance for others to build upon the wealth of experience summarized in the pages that follow.

NISE Net would not have been possible without the early leadership of Mike Roco, and Barry Van Deman and Bill Frascella, formerly at NSF, who proposed a "hub and spokes" approach that led to the network model. Program Officer Al DeSena and his many counterparts from the NSF research directorates have provided ongoing guidance and support. Most instrumental in its development have been Principal Investigator Larry Bell, co-PIs Paul Martin and Rob Semper, past co-PIs Tom Rockwell and Carol Lynn Alpert, and the hundreds of informal learning professionals, scientists, engineers, and others who have contributed. I am proud to have played a role.

"NISE Net has exceeded my most ambitious expectations"

David Ucko served as National Science Foundation (NSF) Informal Science Education (ISE) program officer, then section head, deputy director, and acting division director. In addition to NISE Net, he initiated at NSF the *Framework for Evaluating Impacts of Informal Science Education Projects,* the NRC *Learning Science in Informal Environments* study, and CAISE. Previously, he was founding president of Science City at Union Station in Kansas City; deputy director, California Museum of Science & Industry; vice president, Chicago's Museum of Science & Industry; and a chemistry professor. Ucko has been recognized as a Presidential appointee to the National Museum Services Board, an AAAS Fellow, and a Woodrow Wilson Fellow.

Intro: A Different Kind of Project

LESSON LEARNED:

Out-of-the-box challenges and support from the funder over time can make out-of-the-box results possible.

In January 2005, the National Science Foundation (NSF) issued a program solicitation for a national network dedicated to fostering "public awareness, engagement, and understanding of nanoscale science, engineering, and technology." The network would link museums and other informal science education (ISE) institutions with nanoscale science and engineering research organizations.

The solicitation described an award that would be unlike most NSF grants for informal science education in ways that would shape the future work of the project. While the NSF Advancing Informal STEM Learning (AISL) program typically solicits ideas broadly about what to do to advance informal learning, this solicitation was very specific. It spelled out what was to be done in detail—defining the goals, audiences, and content area for the future network. Instead of asking proposers to figure out *what* the project would be, NSF was asking proposers to figure out *how* to accomplish it.

The need for the project emerged not from the ISE community, but from the National Nanotechnology Initiative. NSF was spending about

a billion dollars each year on nanoscale research and surveys found that the public knew little or nothing about the field and its potential.

"The fields of nanoscale science, engineering, and technology show promise of tremendous impact. Their applications will affect our daily lives and raise issues of societal importance. National competitiveness will require workers who are interested in pursuing nanotechnology-related careers. As a result, there is a growing need to increase awareness and understanding by citizens of all ages of these emerging research areas, along with their implications."

– NSF Program Solicitation, 2005

The funding came not only from the Informal Science Education budget (then ISE, now AISL) within the Directorate for Education and Human Resources, but also from several other research directorates at NSF.

The scope of the project was also unusual as it sought to have impact on an entire field. With an overall award of $20 million over five years and the potential of renewal for a second five years, the investment was much larger and sustained over a much longer period than a typical ISE or AISL grant. This scale created both challenges and opportunities: challenges around the breadth of expertise needed to lead and manage work that was too wide-ranging for any one person or institution to accomplish individually, and opportunities because the resources and timescale enabled the Network to learn and shift strategies over time.

Finally, the award would be a cooperative agreement rather than a grant. As a result, NSF would play a much stronger role in monitoring and guiding the course of the project.

It took time to clarify the goals and strategy

Shortly after the solicitation was released, the Museum of Science, the Exploratorium, and the Science Museum of Minnesota decided to collaborate on a proposal. Through an intense period of cross-continental work sessions and many long conference calls with additional partners, a proposal was written and submitted. After a competitive process, this proposal was selected by NSF for funding. In October 2005, the three lead institutions and 12 additional subawardee institutions launched the Nanoscale Informal Science Education (NISE) Network with the following three outcomes in mind:

• to create a set of interactive media-based, hands-on, and discourse-based educational products that effectively communicate and engage the public with nano,

• to generate essential new knowledge about design for learning for these subject areas, and

• to produce a sustainable network of relationships, alliances, and professional development.

The Network would have two kinds of audiences: 1) the museum-going public, and 2) professionals working primarily in museums and nanoscale research centers.

Ultimately, the NISE Network developed a simplified logic model for accomplishing its work. Through the collaboration of ISE organizations and research centers, the NISE Network would develop a national community. Through the national community, it would create an online catalog of educational products and provide professional development to raise the capacity of the field to engage the public in learning about nano. While some NISE Network products might reach the public directly, the key strategy was to work through ISE organizations and research centers to increase public awareness, understanding, and engagement with nano. In this way, the professional and public goals would be entwined. Engaging the Network community would be essential in increasing the quantity and quality of nano informal education for the public.

Figure 1. Simplified representation of NISE Net logic model
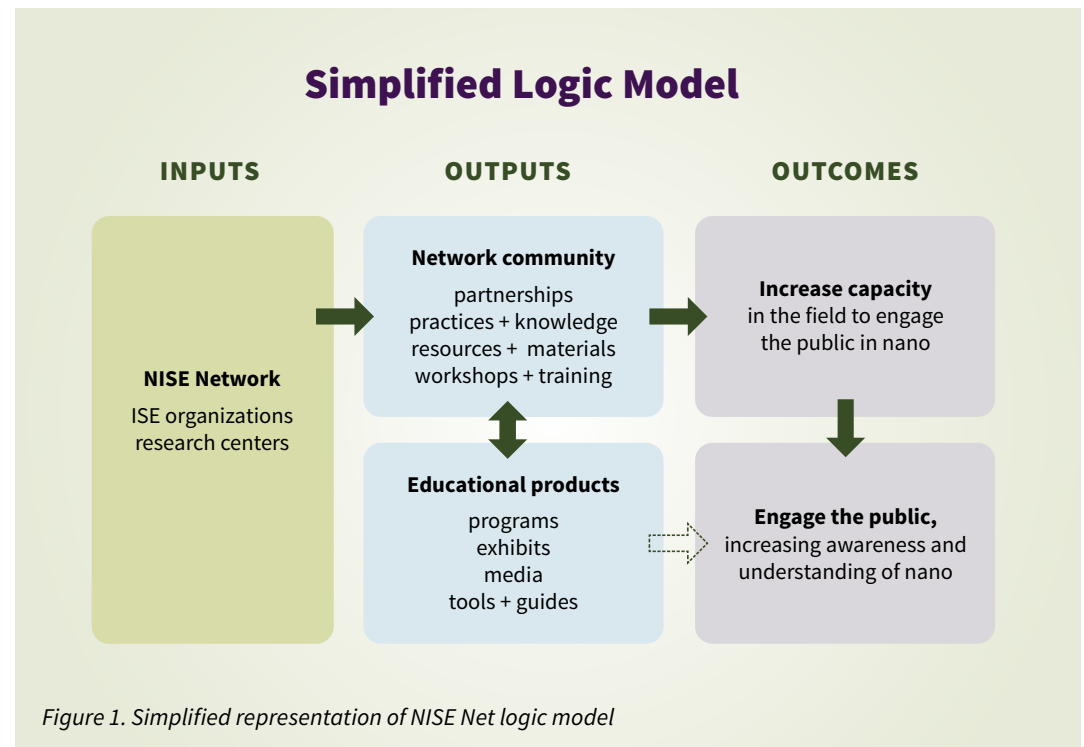
The picture at the very beginning, however, was much more complicated and not nearly as clear as the simplified logic model suggests. The complex and simplified versions of the logic model evolved over time.

There were some significant challenges

Though NSF clearly defined the need for addressing nano, it was not a topic museums were already well-equipped or motivated to tackle. Inverness Research Associates, then leading the summative evaluation of the Network, defined four key contextual challenges the Network was facing:

- The content and pedagogy of nano science education was only just emerging.

- The field was only just learning how to design informal education resources that would effectively communicate nano science to public audiences in ISE settings.

- At the ISE institutional level, there was little expertise, experience, and incentive to do nano education for the public.

- At the ISE field level, there was limited experience in developing and working within a national supportive network.

"A network of this scale and scope is virtually unknown in the ISE field… There were no existing structures or any analogs available for reference. Not only did NISE Net have to create a network rich in working relationships but also had to form an organizational governance system capable of growing and guiding the Network" (St. John et al., 2009).

Change over time was essential for success

The NISE Network changed over time in its quest to meet its challenges. While the three outcomes described in the original proposal remained constant, as did a set of values established early on, the structure of the NISE Network, its strategies for achieving its goals, and the specific projects it undertook, all evolved over time. Some changes were in response to successes, failures, and lessons learned in the Network's own work; some reflected changes in the field, some of which were brought about by the Network's own activities. This guide describes the changes as well as the features and processes of the Network that enabled change and ongoing improvement.

Ultimately the challenges were met

Over a decade later, the NISE Network is a nationwide community with a common identity, purpose, practice, and set of resources. It includes more than 600 museums, universities, and other organizations that work together to engage public audiences in nano. There are over 200 NISE Network–developed programs, activities, exhibits, and media free to download and use in its online library, and more than 50 professional development and training resources. NanoDays, the NISE Network's signature event, has mobilized hundreds of Network partners across the country to engage staff, volunteers, and members of the public in learning about nano each year. By the end of 2015, the annual reach of the Network was 11 million per year and over 30 million people had already participated in NISE Net programs, events, and exhibitions (Svarovsky et al., 2015).

NSF's vision made it possible

The NISE Net's success is due in no small part to remarkable leadership, boldness, and collaboration across disparate groups at the National Science Foundation. The scale of the funding, and the 11½-year span of the award, meant the Network had time to change course as needed, respond to successes and failures, and learn by working together. The openness among the project's program officers to proposals that included unknowns and to-be-defined budgets made the inevitable shifts in direction far easier to enact. Members of the NISE Net Leadership Team believe the Network is a prime example of the profound, field-wide outcomes that funders can achieve when they create and support bold initiatives that go beyond the norm.

Each year

OVER
11 MILLION PEOPLE

participate in NISE Net
programs, events, and exhibitions

NanoDays kits
1 MILLION+ PEOPLE
EACH YEAR

Nano exhibition
10 MILLION+ PEOPLE
EACH YEAR

Figure 2. NISE Net reach

Building the Network: Leadership and Enduring Values

The early Network presented enormous challenges new to the partners involved and to the field. The leadership was faced with the problem of how to build a Network to do what it didn't know how to do, and perhaps initially didn't want to do. The Network would have to experiment, learn, and adapt over time at all levels. During the initial period of development there were many ambiguities and uncertainties, as there are in many new projects. New organizations recruited to participate needed some solid footing to help them understand what they were getting involved in.

"None of us had worked in a network like this before, and many of us hadn't engaged deeply in this kind of content before. It was challenging, and there was a lot of stuff we had to work together to figure out."

– Paul Martin, Science Museum of Minnesota

The solution included two components that provided the foundation for the Network and remained fundamentally unchanged over 11½ years:

• A stable **leadership structure** capable of learning and making decisions about what changes to make over time, and

• A foundational **set of values** that supported ongoing improvement and fostered a desire among members of the field to become a part of this unprecedented project.

Challenge: How to build a network of participants in the face of uncertainty

Figuring out how to tackle nano education at the three lead institutions wouldn't be enough to achieve the goals of the project. The Network Leadership was committed to getting nano into 100 institutions across the country. Making nano work in both very large and very small museums, in rural and urban communities, in science museums, university outreach programs, and eventually even children's museums required new approaches.

In addition to the three lead institutions, NISE Net at the start included 10 additional subawardees, 2 evaluation firms, 12 advisors, and 22 "thinking partners" representing a huge body of expertise drawn from both science museum and university research center communities. This established both an incredibly capable team as well as a diverse set of views on how to address the challenges of the project.

With many challenges ahead, NISE Net needed strategies for ongoing problem-solving and decision-making to provide direction for those at the core of the Network. Furthermore, it needed ways to bring 100 or more organizations into the effort in a way that would make sense to them and support the goals of the project.

Network leadership and decision-making

A leadership group with a diversity of strengths and interests can help anchor a network.

At the core of the proposed network was a partnership between three large science museums: the Museum of Science, Boston; the Science Museum of Minnesota; and the Exploratorium. This partnership served as a foundation to the Network in three ways: the institutions involved brought significant clout, they represented diverse interests and motivations, and they had equal footing from which to negotiate and make decisions.

NISE Net's three lead institutions were leaders in the science museum field in one way or another, which gave them clout with NSF and with other science museum professionals.

- The **Exploratorium**, described by *The New York Times* as "the most important science museum to have opened since the mid-20th century" (Rothstein, 2013), is a pioneer in the kind of inquiry-based exhibits that can now be found in science centers everywhere.

- The **Science Museum of Minnesota** has world-renowned expertise developing high-quality interactive exhibits, with particular expertise in spanning science and humanities topics and using multiple perspectives as a way of presenting controversial societal topics.

- The **Museum of Science** in Boston founded several museum collaborations, and has a strong focus on communicating current science and technology, engineering education, universal design, and public engagement with science.

As other organizations got involved, each brought its own strengths and interests to help lead the Network. The Sciencenter in Ithaca, for instance, had already developed two traveling exhibitions about the nanoscale.

"The Science Museum of Minnesota, the Museum of Science, and the Exploratorium were different and unique. That was a key feature of the early Network design. It was a network designed not to build clones, but a network that people could connect to based on their own different interests and needs."

– Rob Semper, Exploratorium

Each of the lead partners had different motivations for being involved and the Network was designed to allow them to pursue their interests. The Museum of Science was motivated to further its work in current engineering and technology on a national level, and expand recent efforts with programs for adult audiences that included conversations about the societal implications of science and technology. The Science Museum of Minnesota was interested in expanding its work engaging diverse audiences and strengthening the core science at its own facility. The Exploratorium was interested

in visualizations of the unseen world at the nanoscale, distributed learning environments, research on new methods of presentation to the public, and helping to organize the field to increase its impact. Having different motivations created tension: what was important to one organization was not necessarily important to another. But those varied interests and priorities also resulted in a rich set of products. Over the years, the larger Network Leadership group included other co-PIs and workgroup leaders, each bringing different institutional strengths and professional interests to benefit the Network.

LESSON LEARNED:

A small group of ultimate decision-makers may be needed to tackle difficult decisions.

NISE Net established a three-person decision-making body, which became known as the Network Executive Group (NEG).

The three members of this Network Executive Group brought a power balance to the Network. Arguments that came up about what to do were confined to that small group rather than a group of many more who had to come to a resolution on things that had to please everyone. It turned out to be very important to have this smaller group to hash out the problems and agree on what to do.

A series of in-person meetings that went on day and night during the early negotiations helped the NEG members understand what the others needed and wanted to get out of the Network, both individually and institutionally.

In this way the Network had a decision-making body small enough to be able to make difficult decisions, with enough time committed to the project to provide meaningful leadership. Later, others got involved in managing various aspects of the NISE Net's work, including a Network Operating Group (NOG), which played an important role in Network Leadership. The NEG, however, remained the final decision-making body.

"Paul, Rob, and I each had comparable roles in our institutions and in the broader field, and we had mutual respect for each other, which allowed us to grapple with difficult issues from equal footing."

– Larry Bell, Museum of Science

Enduring core values

Over the years a number of questions arose related to working in the Network: how do we meaningfully engage new organizations, what do we expect from them, how do we build capacity across so many institutions, how do we handle intellectual property. Many decisions were informed by the set of core values established in the first few years as a foundation for the Network, which endured even beyond its initial 11½ years of funding.

Underlying it all was the belief that it was possible and worthwhile to engage the public in learning about nanoscale science, engineering, and technology. And with all the NISE Net partners came values endemic to our field, such as "learning should be interactive and fun," and "everyone should have access to science."

The specific challenges and decision-making associated with building the Network called for explicit values and fundamental ways of working that could help to define the NISE Net. Eight of those are described in what follows.

Enduring
CORE VALUES

and fundamental ways of working that helped define the Network:

Building the Network by working together

A Network of partners rather than members

A diversity of partners

Respect for individual organizational needs and interests

Learning together by doing

Ongoing reflection and change

Input, feedback, and evaluation

Sharing

Figure 3. NISE Net's enduring core values

Building the Network by working together

LESSON LEARNED:

Working together in teams with shared experiences can build long-term trust, which is essential for any kind of collaboration.

One of the most important values of the Network has been "building the Network by doing the work together."

This value has been reflected in a variety of ways, including:

• the team structure of the core Network, as much of the development happened within the context of teams;

• the emphasis on partnerships between museums and universities;

• the practice of drawing on diverse experience and educational settings, both in the organizational role of individuals and in the kinds of organizations represented;

• the idea of a national festival—NanoDays—for learning about nanotechnology, which all Network partners would do together during one week in the spring; and

• the distribution of mini-grants to support partnerships and program development, which became an important means of raising capacity and providing professional development across the Network.

This overarching value of building the Network by doing the work together was supported by a number of more specific values and the way in which the Network carried out its work.

"Building the Network by working together was about relationships and capacities, where everybody could find value as an organization and as an individual."

– Paul Martin, Science Museum of Minnesota

A Network of partners rather than members

LESSON LEARNED:

Partners share ownership and contribute to a network project in ways that members may not.

As the Network started to expand beyond the subawardees, there were ongoing discussions about whether the new participants would be "members" or "partners" or something else. The Merriam-Webster online dictionary describes:

• member as "someone or something that belongs to or is a part of a group or an organization," and

• partner as "one of two or more people, businesses, etc., that work together."

While we wanted a growing number of organizations to feel that they belonged, we wanted them to think of themselves as actively working together to achieve the goals of the Network.

Ultimately we decided that the term "partner" best represented the role new participants would take. Partners would bring their own goals and motivations to the work, they would be able to add their own insights, and would adopt the practices or content in ways that felt genuine and sustainable. A "member" of a network might participate and take resources, whereas a "partner" is expected to contribute, shape the larger network, and share ownership. The Network would not simply be a mailing list with a one-way flow of information and materials.

A diversity of partners

> **LESSON LEARNED:**
>
> *Diversity of partners—in their experience, context, and interests—from museums and universities can contribute to the success of a network.*

In the earliest days of the Network, the interdependence of institutions with different work cultures, philosophies, and motivations generated stress. Aligning work schedules and processes and coming to consensus on complex matters was challenging. Regardless, the Network understood from the start that the diversity of the funded partners was a strength. Each institution involved brought its own particular expertise to the Network, such as the perspective of

Who are the partners?

The NISE Net adopted a tiered structure of involvement as an internal way to acknowledge and account for the different levels of commitment partners might bring to the Network and what the Network expected of them.

TIER 1 – Core Partners were the 14 or so organizations funded at any one time to lead the work of the NISE Network, also called subawardees.

TIER 2 – Nano-Infused Partners evolved from the original target of nano education in 100 places. They were museums and universities working to integrate nano content into a wide range of their own ongoing educational activities and received the most support from the Network.

TIER 3 – Broad Reach Partners included museums, research centers, libraries, schools, and others with interest and capacity for only occasional public nano educational activities or for implementing them in their own entirely independent way.
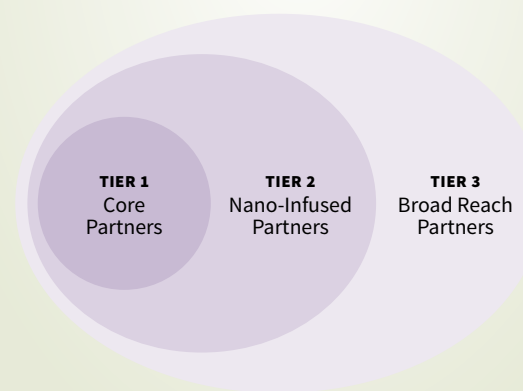

TIER 1
Core Partners

TIER 2
Nano-Infused Partners

TIER 3
Broad Reach Partners

Figure 4. Three tiers of NISE Net partners

working in a small museum or as a university outreach professional, experience working with underserved audiences or very young children, experience in creating exhibits or programs, or other kinds of educational experiences.

NISE Net had a particular focus on bringing together professionals from informal science education institutions and from universities that research emerging science and technology. University partners could bring knowledge about the new and emerging field of nanotechnology to the Network while informal science educators could bring expertise about engaging public audiences in learning about science.

"NISE Net created an extensive community by drawing in many different types of partners and organizations including 268 museums/science centers, 203 colleges/universities, and 127 other types of institutions, such as K–12 schools, libraries, and industry or government organizations" (Bequette et al., 2016).

Respect for individual organizational needs and interests

LESSON LEARNED:
Encouraging customization and adaptation to meet the needs of partner organizations and audiences can be enabled through strategies to support quality rather than requiring uniformity.

Recognizing that partners' diverse needs and interests meant they would have diverse ways of participating in the Network presented opportunities, but it also presented a challenge.

The concept of "faithful implementation" in education is the idea that a new program or innovation would be developed, proven to be effective, and disseminated to other teachers. Those teachers would be responsible for implementing the program or innovation exactly as it was designed—making as few changes as possible in order to ensure consistent outcomes. The original plan for the Network was not far from a faithful implementation model. But the leadership quickly learned that requiring cookie-cutter implementation would not work if they wanted to get nano ISE into 100 institutions. The museum field is highly individualistic; museums have different missions, approaches, and constraints for educational programming that they feel best meets the needs and expectations of their local communities and audiences.

Early feedback from potential partners indicated that they were not interested in products that couldn't be adapted to meet their own needs, audiences, and settings. So the Network focused its efforts

on ensuring that educational products could be modified to meet the needs of individual organizations and their audiences. Designing for adaptation may be more expensive and time-consuming up front, especially in terms of making digital files easily modifiable and securing and assigning rights to imagery and other media assets. However, this approach has proven to be very valuable to the Network.

In the absence of uniformity, to encourage and support a high quality of educational program delivery the Network created resources such as individual activity and educator guides, tip sheets, training videos modeling delivery of programs, and professional development tools focused on best practices, and offered a variety of in-person and online professional development workshops and webinars.

Learning together by doing

LESSON LEARNED:
Learning by doing can be a powerful strategy for innovation and capacity building.

"Learning by doing" is fundamental to the approach that science and children's museums take to support learning among their visitors. So it should be no surprise that learning by doing was fundamental to the work of the NISE Net, starting with the leadership of the Network itself.

The original NISE Net work plan laid out two phases for the first five years of the project. The first phase, in Years 1–2, would be focused on research and development. There would be a review of existing ISE projects around nano, research focused on effective ways to

communicate cutting-edge nanoscale science, and rapid prototyping of exhibits, programs, and media ideas. The work was intended to be exploratory and informed by intensive formative evaluation. There were several workgroups at the launch focused on administration, visualization, forums, exhibits, programs, media, professional development, annual meetings, a professional resource center, a public website, and research and evaluation.

> *"We had a strategy of building a network that involved doing a set of experiments and then deciding at the end of two years where we'd go from there. It was a strategy we talked about very openly at the start of the project so we didn't get tied down at the beginning."*
>
> **– Rob Semper,** Exploratorium

The leadership planned that at the two-year milestone it would look across the work from the first two years and set a new direction for the remaining three years based on the work to date. This strategy built flexibility and the opportunity to learn into the Network timeline. It also enabled the workgroups to start work immediately, rather than waiting to answer all the unknowns first. By doing the work, the teams would learn how to do the work.

In the second five years, this notion was extended more broadly throughout the Network with the distribution of mini-grants and by encouraging a kind of do-it-yourself formative evaluation the Network called Team-Based Inquiry (TBI). Within the museum field, scientific inquiry skills are highly valued as ways to meaningfully

engage visitors in science learning. This way of working translated the value the field held for enabling visitors to "learn by doing" to the field's own learning and professional development.

Ongoing reflection and change

LESSON LEARNED:

Continually reading the changing conditions, learning from earlier work, and adjusting plans to take advantage of new possibilities can be key to the success of a network.

The idea that the changes made at the two-year point would set the NISE Net on a fixed course for the rest of its years was quickly seen to be unrealistic. Changing conditions both required and enabled repeated examination and adjustment of the course throughout the project. A requisite for "learning by doing" is being open to making changes over time. Over 11½ years, the Network learned quite a lot. It learned about making nano content relevant to visitors. It learned about designing engaging experiences about nano. It learned about the needs and motivations of partner institutions for different types of programming with different audiences in different settings. It learned which of its initial activities were central to the development of the Network and which were tangential.

As the Network developed, it changed conditions in the field. Things became possible that were not possible at the start. Where potential partner museums initially had very little interest in tackling nano

topics, by Year 5 the Network had hundreds of museums across the country hosting annual events related to nano called NanoDays. Research centers and universities became aware of NanoDays as an opportunity to collaborate with museums, and over time, participation among NSF-funded nano research centers became a field norm. A content map was developed articulating the content knowledge the Network identified as most important for engaging the public in learning about nano. High-quality, easy-to-use hands-on activities designed for informal settings now existed, were available for free download, and had already been distributed in physical form to organizations nationwide.

"We weren't afraid to try stuff out. If it worked we went with it, and if it didn't work we changed direction and tried something else."

– Paul Martin, Science Museum of Minnesota

These conditions enabled the Network to do more than it could before. It could award mini-grants to support partners in developing sustainable nano projects for their institutions because the motivation, staff capacity, and supportive resources had been developed. The Network could identify gaps in the content covered by existing educational materials, and in the educational practices implemented by partners, and develop materials and trainings designed to fill those gaps. And while NISE Net halted its exhibit work in the first five years because interest in exhibits about nano was initially low, in the second five years, NISE Net could return to exhibit development in the form of a small-footprint exhibition that could be extensively replicated and widely distributed.

most successful with visitors. It clarified potential partner needs and interests in participating in the Network as they evolved over time. It helped to improve meetings and workshops, and identified gaps in coordination among different areas of work.

Evaluators were also active members of the Leadership Team. From the early days of crafting the proposal through the submission of the summative evaluation report in Year 4, Mark St. John of Inverness Research advised the Network Executive Group on network development. When summative and formative evaluation work was integrated into one cohesive multi-institutional team in Year 6, the head of the evaluation group joined the Leadership Team to inform Network decision-making for the remainder of the project.

Input, feedback, and evaluation

> **LESSON LEARNED:**
> *Evaluating outcomes and soliciting partner input and feedback is important for guiding changes in a network.*

"We used a rigorous development process that included peer review with educators, expert review by scientists, and visitor testing. By listening to all these perspectives and responding to their suggestions and ideas, we were able to make educational products that were high quality and useful for partners across the country."

– Rae Ostman, Science Museum of Minnesota

Learning by doing and making changes as you go both rely on having a way to determine what's working and what isn't. In the NISE Network this resulted in a deep commitment to gathering and responding to feedback from target audiences formally and informally at all levels of the work. Formally, evaluation and evaluators were integral to the evolution of the NISE Network. Evaluation provided valuable insight into which exhibit and program prototypes and overall directions were

The emphasis on user feedback went beyond formal evaluation. When the Network began distributing NanoDays kits full of hands-on activities, supplies, signage, and training materials, it gave them to partners free of charge. In exchange, kit recipients had to commit to using the materials with public audiences and providing

feedback on what worked, what could be changed, and what would be helpful in the future. Partners who didn't use the kits sufficiently, or didn't report on their use, were much less likely to receive future kits. Over the years, this practice of distributing resources and providing support in exchange for doing work and providing feedback remained consistent across opportunities for participating in professional development trainings, receiving mini-exhibitions or mini-grants, and more. Partners came to understand that the Network wanted and expected to hear from them. They saw that Network Leadership was making changes based on their suggestions and insights. Meanwhile, Network leaders and workgroup members became accustomed to soliciting user feedback and incorporating it into decision-making as an integral part of their work.

LESSON LEARNED:

New approaches to evaluation can help infuse evaluative practices into all of the work of even a very large network.

As Network practices became more sophisticated, each workgroup team had a member of the internal Evaluation Team assigned to participate in meetings. Waiting for formal reports to be written sometimes meant that needed feedback would come after new activities were already underway. Including evaluators in teams meant that findings could be an ongoing and more timely part of workgroup discussions and decision-making. Relevant findings and data could be clarified in the moment. Evaluation activities could be added or modified to meet the needs as Network plans changed.

"The NISE Net was always hungry for data to inform their decision-making. By moving to TBI in Year 5, we were able to give partners the skills they needed to collect some of their own data instead of always relying on us."

– Elizabeth Kunz Kollmann, Museum of Science

In the second five years of funding, the demand for formative evaluation grew beyond the Evaluation Team's capacity or budget, and practitioner-based methods for gathering feedback were codified and formalized as Team-Based Inquiry (TBI). Program developers, meeting and workshop organizers, and everyone participating in NISE Net project teams and workgroups were trained to formulate relevant questions, gather information, and reflect on data to improve their work.

The demand for research and evaluation data and feedback from the Network also grew in the second five years of funding. To avoid over-surveying Network partners, the Evaluation Team implemented an annual partner survey that incorporated questions to meet the needs of the various research and evaluation groups, Network Leadership, and the various Network workgroups.

The structure of the Evaluation Team changed over time. The Network shifted from dividing the evaluation across two "external" summative evaluators and an internal formative evaluation team to a single multi-institution internal team with an external Committee of Visitors to review the work to ensure objectivity. Members of the Leadership Team joined evaluation subgroups to help improve communication across evaluations and between evaluation teams and project teams. But throughout, the close integration of evaluation in all levels of the work was consistent and demonstrated the extent to which the Network valued feedback and evaluation.

(For more about NISE Net evaluation, see Kollmann & Beyer, 2016.)

Sharing

LESSON LEARNED:

Open sharing of resources can facilitate greater use of project products.

The Network was built around ideas of learning and building a network by doing work together, drawing on diverse expertise, enabling partners to take ownership, and using feedback and evaluation to continually improve products and practices. These values were enabled by a culture of sharing—of expertise, experience, feedback, resources, and intellectual property.

Initially, sharing of intellectual property involved some leaps of faith and negotiating of boundaries. There was the concern of "faithful implementation" discussed earlier. Many professional and institutional cultures have concerns about putting one's work out

into the world for anyone to modify, adapt, and reuse. In addition, many institutions considered (and still consider) the intellectual property associated with their exhibits, programs, images, media, and more to be sources of revenue. But as Paul Martin said, "What was the worst that could happen? An exhibit developer would take the NISE Net's exhibit plans and start selling them to museums across the country? Then museums across the country would end up with nano exhibits and the project will have achieved its goals!"

The spirit of sharing one's work broadly with others became an accepted part of what it meant to participate in the Network.

"NISE Net is committed to sharing the knowledge and products they have developed with the field."

– St. John et al., 2009

Please indicate if you have made any of the following modifications to any NISE Net product in the past 12 months:

I have...

INCORPORATED *a NISE Net product into an existing program*	**75%**
ADAPTED *a NISE Net product for a different audience*	**54%**
COMBINED *NISE Net products to make a longer program*	**51%**
CHANGED THE FORMAT *of a NISE Net product*	**31%**
CHANGED THE MESSAGES *of a NISE Net product (educational messages)*	**9%**
MADE NO MODIFICATIONS *to any NISE Net product*	**5%**
MADE A MODIFICATION *not listed*	**16%**

(n=259)

The majority of Year 10 annual partner survey respondents who engage the public in nano have made modifications to NISE Net products though few have changed their educational messages (Goss et al., 2016).

Figure 5. Survey results: Modifications made to NISE Net products

Summary: How the values helped the project meet the challenges

The overarching concept of building the Network by working together and the various ways in which that was manifested—the core values and the practices that grew from them—helped the Network to form and grow. Despite the top-down nature of managing a high-stakes NSF award, these principles balanced the push and pull within the overall project, and established the social nature of the Network built upon relationships, mutual interests, and reputation. That participants would be "partners" signaled complementarity and accommodation, and enhanced the status of those involved. Through constant feedback, the Network tapped into the collective intelligence of its partners and was resilient because of its flexibility. The commitment to sharing provided access of information, knowledge, and materials to everyone.

Much has been written about networks and similar organizational structures in the last decade and some of this was known when the NISE Net was launched, but not very well known by members of the science museum community.

Looking back today, we can see how the NISE Net came to embody many of the features and strengths of networks described in the research literature summarized in Figure 6.

Key Features of Networks:

• More social than markets and hierarchies, network organizations are dependent on relationships, mutual interests, and reputation.

• Successful networks involve complementarity and accommodation. Reputation, friendship, interdependence, and altruism are integral.

• Reduction of uncertainty, fast access to information, reliability, and responsiveness are paramount concerns that motivate participants in network organizations.

 (Powell, 1990)

Strengths of Networks:

• Access to information, knowledge and experience

• Resiliency: "the ability to survive and thrive in the face of change"

• Credibility: participation can enhance individual members' status and the organization's reputation

• Reach: the ability to reach more people more quickly or effectively

• Diffusion of knowledge and innovation: providing a fast, reliable way to communicate learning and ideas

• Collective Intelligence: "a well-connected, trusting, and fluid network has access to the generative and creative abilities" that make the sum more than its parts

• Individual and network performance

(Anklam, 2011)

Figure 6. Key features and strengths of Networks

CHAPTER 3

Constant Change: Developing the Network over Time

While the NISE Network was built upon a foundation of enduring core values, the strategies and structures changed significantly and repeatedly over the 11½ years of NSF funding. These changes came in response to feedback from partners, evaluation results, and changing field conditions as the Network developed. Some of the changes in the field were the result of NISE Net's own work. Change beyond what was imagined at the start was essential to the growth and success of the Network. This chapter addresses the changes in the activities of the Network through the lens of the Network management structure.

Challenge: How to organize the Network to meet changing needs

Changing Network structures represented solutions to a certain set of challenges, what was known at the time, the situation in the field, and the current development of the Network. The aim of this chapter is to describe the changing Network administrative structures, the challenges they were designed to address, and their strengths and weaknesses.

As the Network grew and evolved over time, different needs emerged or rose to the top. They included:

• How to manage a lot of different development work beyond what any one team or organization could carry out on its own

• How to monitor the use of funds by a large number of subawardees and ensure that the work is being accomplished

• How to effectively draw on the diverse pool of expertise required to solve the unique challenges of nano ISE and ensure that innovations would be valuable in a variety of settings

• How to expand the Network beyond the core funded partners

• How to build flexibility into the Network in order to respond to feedback

• How to create shared goals and strategies among many organizations, and how to communicate this—particularly as the goals and strategies shift

• How to draw on the expertise created within the Network and allow partners to share their own innovations

"Over the years, the NISE Net management structure has evolved from a structure of 'strands' of work based at individual institutions to cross-network multi-institutional working groups."

– St. John et al., 2009

Network or hierarchical structure

LESSON LEARNED:

A network structure may need hierarchical components to satisfy funding requirements and facilitate decision-making.

Networks are built upon the active involvement of all of their members, so NISE Net needed to be attentive to the broad community of partners that Network leaders wanted to engage. But as NISE Net was funded through an NSF award, there were a number of responsibilities that required hierarchical structures.

As the primary awardee of the grant, the Museum of Science was responsible to NSF for ensuring the work was accomplished and the money spent appropriately. Each additional funded partner was a subawardee of the Museum of Science, meaning Museum of Science was also responsible for monitoring their work and spending. Museum of Science shared responsibility for overall strategy and funding decisions with the Science Museum of Minnesota and the Exploratorium through the Network Executive Group initially, and monitoring of workgroups through various forms of the Network Leadership Team whose members were drawn from the subawardee organizations.

Complex networks can be challenging to visualize, particularly if you want to show the different roles of various members and their relationships to each other. This is the diagram shared at the beginning of the project but quickly abandoned in favor of simple representations of geographic distribution and structural depiction of the hierarchical leadership components.
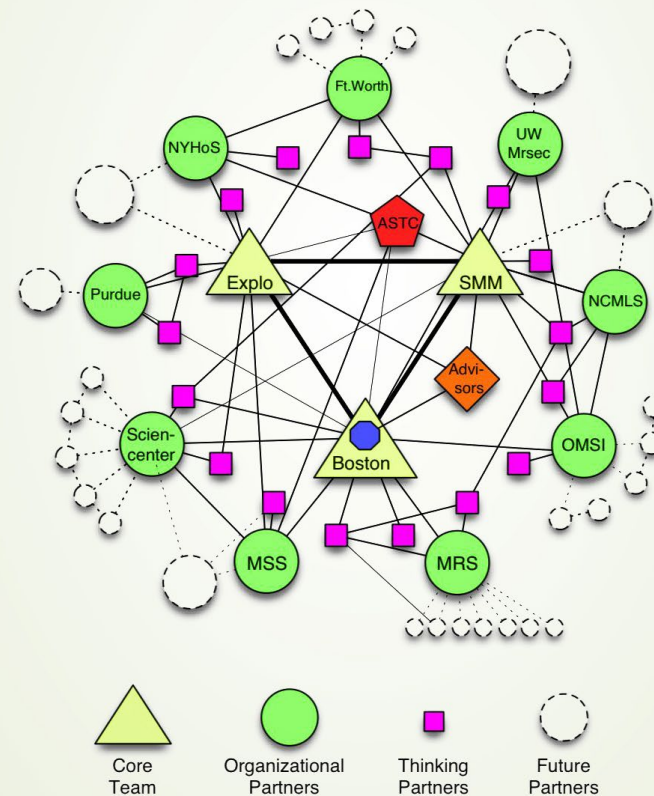

Figure 7. Early depiction of NISE Net structure

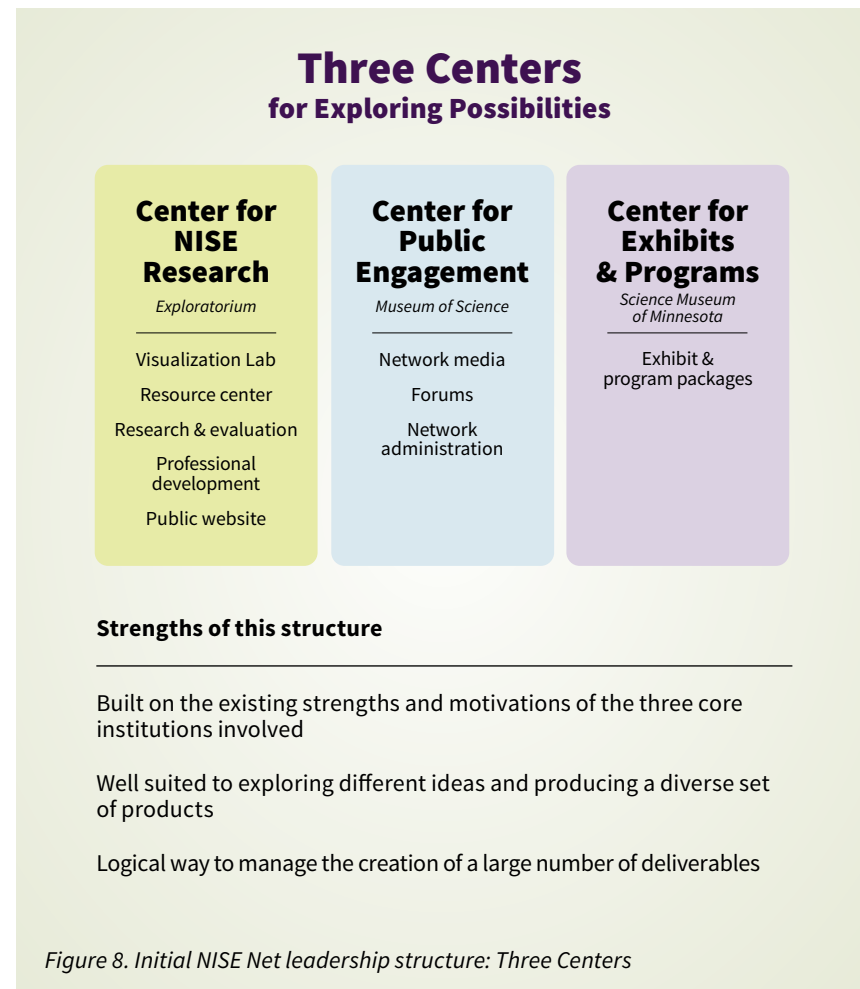### First structure: Three centers for exploring divergent possibilities

> **LESSON LEARNED:**
>
> *Organizing the work initially into separate, coordinated centers can allow a network project to explore multiple possible directions quickly by drawing upon the diverse interests and expertise in the field.*

NISE Net started as a partnership among three organizations: the Museum of Science, the Science Museum of Minnesota, and the Exploratorium. The original structure of the Network looked like three centers, each with a different set of responsibilities based on the interests and strengths of the three initial partner institutions. Within each center was a set of working groups involving different combinations of staff from the broader group of subawardee partners. They were responsible for developing, evaluating, and making available a variety of educational deliverables. This model had a familiar "academic" feel to it, like some large-scale multi-institutional research centers, and it gave each of the core partners its own role in leading part of the work.

The first two years were designed to be an R&D phase, dedicated to pursuing a variety of different ideas aimed at creating a rich and diverse set of possible products. But Network leaders had to have an idea of the possible five-year output of the project. The initial plan

was to create, among other things, a set of "exhibit packages" of varying sizes that included exhibit components, media, and program templates. The model was to form a network of developers and their advisors to create exhibit and program materials and distribute them to 100 sites.

Three Centers
for Exploring Possibilities

Center for NISE Research	Center for Public Engagement	Center for Exhibits & Programs
Exploratorium	*Museum of Science*	*Science Museum of Minnesota*
Visualization Lab	Network media	Exhibit & program packages
Resource center	Forums	
Research & evaluation	Network administration	
Professional development		
Public website		

Strengths of this structure

Built on the existing strengths and motivations of the three core institutions involved

Well suited to exploring different ideas and producing a diverse set of products

Logical way to manage the creation of a large number of deliverables

Figure 8. Initial NISE Net leadership structure: Three Centers

But when the Leadership Team talked with potential partners in 2006, they learned that there was relatively little interest in hosting either additional traveling or large permanent exhibits on nanotechnology. There was much greater interest in programs, activities to do with school groups, and professional development. Network partners also indicated that they valued relationships with peers in other organizations and members of the research community as much as they valued educational materials. They also said that they wanted to work with the Network in a variety of ways and no one product was of interest to all.

LESSON LEARNED:

Capacity and interests of the potential partners of the network you are trying to build may require changes in your plan of action and leadership structure.

Focusing less on exhibits and more on programs would require more active engagement of staff at the targeted 100 sites across the country. Educators everywhere would need to learn about nanotechnology and nano informal science education possibilities. They would need to be trained in the use of the materials the Network was developing. As Inverness Research told the Leadership Team in Year 2, "Facilitating and coordinating the relationships of 100 ISE partners will take an incredible amount of organization, clear communication, flexibility, and vision" that simply wasn't in the Network organizational model at the time.

LESSON LEARNED:

Independent centers working in parallel on educational resource development may not be a good structure for the coordinated and responsive efforts needed to build a network.

Comments from NISE Net partners at the time provided additional clues to changes that needed to be made.

"There are two levels that I think it would be helpful for us to think about. There's the network as a project, and there's the network as a functioning network. Both sides need serious attention in thinking about them administratively. In both cases, the processes we have in place are not robust enough to get the work done that we've laid out."

(Anonymous NISE Net partner quoted in St. John, 2007.)

"It was not a mistake to start the way we did, because we had to try out a lot of things to see what would actually work. But it would have been a mistake to continue on that path."

– Larry Bell, Museum of Science

Second structure: A focus on building the Network

LESSON LEARNED:

Changing the direction of a massive project may be necessary, but challenging for the people involved.

Implementing substantial change in a massive project is a challenging process because of all the work underway and all the people actively engaged in moving it forward. Since museums didn't have much intrinsic motivation to address nano with their visitors, the Leadership Team could envision a future in which a wide range of educational materials and activities were developed but no one used them. The project had secured the enthusiastic participation of subawardees by paying them for their work, but it couldn't use the same method to get 100 partners involved in an ongoing sustainable way. Partners needed to want to offer nano informal education to their visitors without receiving funding. So NISE Net had to shift from putting all of its efforts into educational material development and instead focus on other kinds of activities that would support the building of the Network itself as a group of 100 partners solidly committed to engaging their local audience in nano. The Leadership Team called this dramatic change in direction the "inflection point."

In parallel to the educational product development work, NISE Net added an area of work focused on building and supporting the Network community. It clarified a third area of work that supported the other two—project management—and furthermore recognized that all three areas of work needed in their own ways to support the building and maintenance of the Network.

"It was a transition from three autonomous centers to one coordinated Network, and that meant each of us had to give up things that weren't as central to supporting the Network. There was a process of shedding institutional allegiances along the way that was difficult."

– Larry Bell, Museum of Science

Three Workgroups
for Building the Network

Educational Products	Project Management	Network Community
Exhibits	Administration	RISE steering
NanoDays	Research	Network hubs
Programs	Website	Regional & Children's Museum Hubs
Public engagement	Evaluation	
Content steering		
Diversity, equity, and access		

Strengths of this structure

Supported building the Network well beyond the target of 100 partners

Provided better mechanisms for gathering input from the wider community and using it to inform the Network

Provided the connection and coordination needed for effective management of a very large effort

Figure 9. Second leadership structure of the NISE Net

Setting institutional interests aside may be necessary for network core partners to lead a network successfully.

The three newly defined areas of work were cross-institutional and not identified with any of the three lead organizations. They were not the work of the Museum of Science, the Science Museum of Minnesota, or the Exploratorium—they were the work of the NISE Net.

Concerted effort may be needed to build a network around needs that do not initially arise from the network community itself but rather from the funding source.

The Leadership Team talked about NISE Net being a "push" network, because the goals it was given by NSF did not arise within the broader community, but instead represented NSF's need to inform public audiences about nano research. NISE Net needed new strategies to engage its professional audience in nano.

NanoDays

This was one of the most important additions to the project for building a community that ultimately included hundreds of organizations engaged in informal nano education. It was launched in part to serve as a Network-wide focal point, a deadline for finishing work across multiple workgroups, and a means of gathering and distributing resources. It was also an easy and concrete thing for new organizations to do to be part of the Network and to partner with other organizations in doing so. The NISE Net would provide to partners for free a high-quality ready-to-use kit of educational materials and training resources if they would use the materials and report back on their use. To create a national event out of smaller events at 100 or more sites, NanoDays was scheduled for one week in the spring each year during which a kind of national festival of

nano informal education would take place in every state of the US, DC, and Puerto Rico. Over time, participation in NanoDays became a definition of what it meant to be a NISE Net partner. NanoDays kits were not only useful, they were also motivating and gave partners a low-risk way of getting involved.

Figure 10. Over eight years, 1,650 NanoDays kits were distributed to 468 different organizations.

Content Map

Because partners wanted to customize or adapt educational materials for their own varied uses, the educational product work included not only the educational products themselves but also guidance in connection with using, modifying, or developing educational products. A content steering group began to focus on defining the range of subject matter relevant to nano informal education. Disseminating this guidance throughout the Network allowed partners to take more control over their implementation of nano informal education.

NISE Net has identified four key concepts for engaging the public in nano:

1. Nano is small and different: Nanometer-sized things are very small, and often behave differently than larger things do.

2. Nano is studying and making tiny things: Scientists and engineers have formed the interdisciplinary field of nanotechnology by investigating properties and manipulating matter at the nanoscale.

3. Nano is new technologies: Nanoscience, nanotechnology, and nanoengineering lead to new knowledge and innovations that weren't possible before.

4. Nano is part of our society and our future: Nanotechnologies—and their costs, utility, risks, and benefits—are closely interconnected with society and with our values.

(Bequette et al., 2012; see also Sciencenter, 2011).

Diversity and Inclusion

In addition to providing guidance on relevant content, NISE Net established a diversity, equity, and access group to share strategies for serving underrepresented audiences. Ultimately NISE Net produced a variety of guides, workshops, and online discussions focused on such topics as bilingual and universal design, and included Spanish language versions of its educational activities in NanoDays kits.

Regional Hubs

Another major addition crucial to building the Network was a regional hub structure serving all of the US in what ultimately became seven regions along with two "audience" hubs focused on children's museums and international partners.

> *"Regional hubs created a path for institutions to join the Network and helped track partner involvement. They provided clear communications channels and easier ways to match scientists and museums."*
>
> **– Catherine McCarthy,** Science Museum of Minnesota

The Regional Hub Leaders, who formed the core of NISE Net's Community Group, developed materials and activities that were aimed at establishing connections between potential partners and the NISE Net, building relationships among partners, providing fast access to information when it was critically needed, and providing partners and potential partners with a friendly point of contact with the Network.

Regional Hub Leaders later played a wide range of roles in decision-making about the distribution of Network resources because they were knowledgeable about the partners in their regions.

Regional Hub organizations
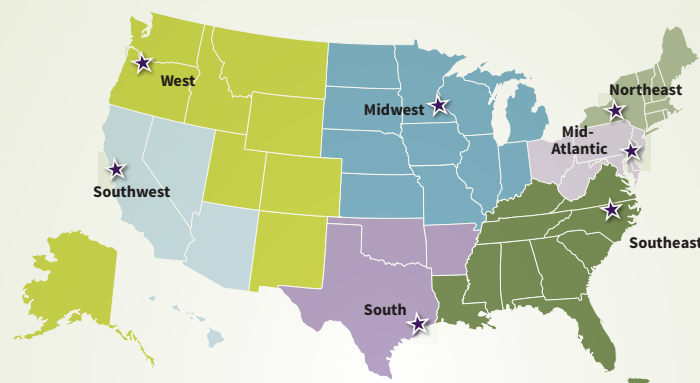
Sciencenter, Ithaca, NY

The Franklin Institute, Philadelphia, PA

Museum of Life and Science, Durham, NC

Fort Worth Museum of Science and History, Fort Worth, TX *(through 2010)*

Children's Museum of Houston, Houston, TX *(after 2010)*

Lawrence Hall of Science, Berkeley, CA

Oregon Museum of Science and Industry, Portland, OR

Science Museum of Minnesota, St. Paul, MN

Figure 11. Seven NISE Net regional hubs

RISE

NISE Net also launched a working group focused on research center and informal science education (RISE) partnerships. NSF's funding for nano research was coordinated under the umbrella of the National Nanotechnology Initiative and groups of research centers were funded across the US. Stimulating partnerships between research centers and science museums was one of the goals of the Network. The Materials Research Society was also one of NISE Net's funded partners and developed a program to recruit individual scientist volunteers to work with NISE Net partner museums. The RISE workgroup developed connections and collaborations with other

scientist professional organizations and developed a range of guides, workshops, and other resources to support sustained partnerships between university research organizations and science museums.

Website

Another important component of the network-building structure was the website, *nisenet.org,* which served not only as a dissemination tool and repository for all the materials the Network created, but also as support for the partnering efforts and for providing a window into NISE Net activities accessible by all. By 2016, the online library included hundreds of resources on nano informal education and best practices in informal education overall. Everything the NISE Net has developed and everything going on in the NISE Net is available on the website.

Network Operational Group

This new Network structure was much more interconnected than the first, and much more focused on engaging professional communities. A Network Operational Group (NOG) was established to complement the Network Executive Group and oversee the day-to-day work of the Network. Each member of NOG was responsible for one of the three arms of the Network and/or led one or more workgroup, ensuring the work was coordinated, thinking about how it contributed to the larger whole of the Network, acting as a conduit between the workgroups and the leadership group, sharing information, and answering questions. Because the Network Executive and Operational Groups met together nearly every week, this structure gave the workgroups much more information and insight into what was happening across the project, and much more voice in the direction the project was taking.

Third structure: Using the Network to reach the public with an eye toward sustainability

> **LESSON LEARNED:**
> *Sustainable large-scale public impact may require new efforts once a network is built.*

As the work continued and the Network matured, NISE Net had a library of hundreds of informal educational resources and also hundreds of partners, five or six times the original goal. But with a public engagement model focused on programs, the public reach was only about one million people per year.

To reach more people, NISE Net leaders returned to the concept of exhibits in many institutions. Although NISE Net had abandoned exhibit development a few years earlier, the success of NanoDays had created an interest throughout the science museum community (and even the children's museum community) in having long-term exhibits about nanoscale science, engineering, and technology. The Network developed the *Nano* mini-exhibition, a small-footprint exhibition organized around the four big ideas in the NISE Net Content Map and included both information resources and interactive exhibits.

Ultimately 93 copies were produced and distributed, resulting in engagement of an estimated 10 million visitors each year.

A second strategy aimed at sustainable impact was the competitive awarding of about 40 mini-grants per year of up to $3,000 each to partner organizations that would apply and meet at least one of three criteria related to sustainability, partnerships, and serving underrepresented audiences. Mini-grants were designed to embed nano education into partner institutions in ways that they found valuable and would be sustained in the future, adding to the further reach of nano educational activities.

> **LESSON LEARNED:**
> *A network can gain the ability to build its own capacity as it matures, even if it is designed to push initially unfamiliar content and practices throughout a community.*

The NISE Network Communication Study was completed in April 2012, and examined NanoDays, in-person meetings, regional hubs, and the website as mechanisms for communication within the Network. One key finding was that active partners of all tiers wished to know more about the nano educational activities happening throughout the year at other partner institutions. Network Leadership knew that partners were modifying or combining activities they received in NanoDays kits and were using them for a wide range of programs. This report made it clear that partners were particularly interested in hearing how

other institutions in the Network modified or adapted activities, especially for children, family, and adult audiences. They wanted to know how other institutions were integrating nano beyond the yearly NanoDays events and activities, and how to put NanoDays components together to create more extensive programs about nanotechnology and its significance. They didn't want to just hear more, they also wanted to share more with other institutions about their own work.

This was an encouraging finding to the leadership group. Originally there was little motivation among museums to do nano outreach and little expertise in it. That was no longer the case. Hundreds of museums, science centers, and research centers were doing nano outreach. Experience and expertise in "doing nano for the public" had become widely distributed throughout the Network. The challenge of the Leadership Team became finding ways to build communication among NISE Network partners and allow partners to learn from each other directly.

The Network was also facing the end of its NSF funding. The Leadership Team was grappling with questions about how to sustain the impacts of the Network after the dissolution of the funded infrastructure (assuming additional funding was not found). One approach was shifting the focus of work even further away from developing more new educational materials and toward making sure materials already developed got into the hands of partners and strengthening partners' capacity to continue this work on their own.

In Years 6–10, Network-wide meetings and regional meetings focused more explicitly on featuring work developed by partners in Tiers 2 and 3. This included presentations during concurrent sessions, poster sessions, and showcases. The work of meeting organizers

"After the Network Communication Study, we implemented more cross-network communication, mini-grants, webinars, and a different approach to the programming of the national and regional meetings, so that more of the content and direction of the Network came from the Network itself rather than from the leaders."

– Larry Bell, Museum of Science

became one of organizing and enabling the partner presentations. To support these new directions, changes were again made to the workgroups. Two new groups were launched to focus on building capacity. The Team-Based Inquiry (TBI) professional development effort trained partners in conducting their own formative evaluations through an ongoing cycle of questioning, investigating, reflecting, and improving. Online brown-bag webinars were set up as informal conversations, giving partners an opportunity to share their own work with others in the Network.
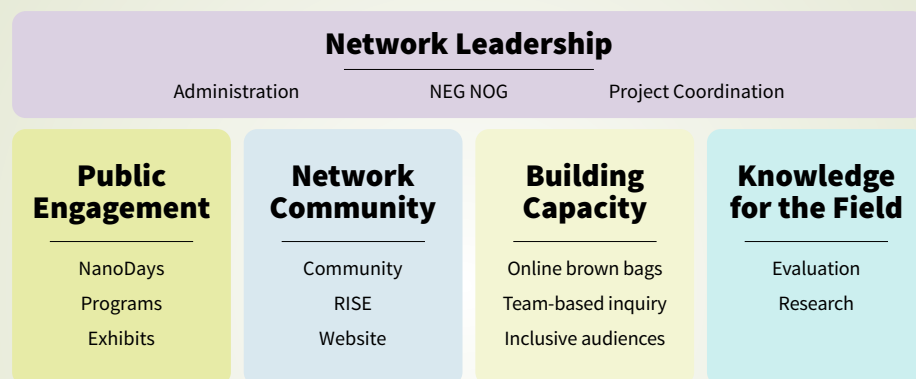
Integrated Workgroups
for Sustained Impact

Network Leadership

Administration   NEG NOG   Project Coordination

Public Engagement	**Network Community**	**Building Capacity**	**Knowledge for the Field**
NanoDays	Community	Online brown bags	Evaluation
Programs	RISE	Team-based inquiry	Research
Exhibits	Website	Inclusive audiences	

Strengths of this structure

Support for sustainable impact beyond the funding of the project

Support for building the capacity of the Network partners for future projects on other topics

Support for the capacity of the larger field through sharing of lessons learned

Figure 12. Leadership structure of the mature Network

Summary: How constant change helped the Network develop over time

Faced with a wide array of challenges, NISE Net had to adapt over time. With a strong system of feedback and evaluation, NISE Net leaders could learn what was working and what wasn't. A commitment to ongoing improvement was essential, and more ongoing change was required than initially anticipated. Developing the identity of NISE Net as an organization and maintaining a reputation for high-quality educational materials was key. A mixture of unchanging underlying values and constant change were essential to the NISE Net's success.

The challenges the NISE Network faced are likely not unique. Many networks or multi-institution collaborations will likely face similar challenges. The answers the NISE Net established are not the only right answers to those challenges. But it is the authors' hope that the experiences that NISE Net leaders had might be helpful to others grappling with similar challenges.

CHAPTER 4

Running the Project: Administrative Processes and Tools

While enduring core values and structures to support change were essential to the overall success of the NISE Network, the "nuts and bolts" of Network administrative processes were essential to making it run smoothly. With a heavy roster of subawardees and partners, constant change to monitor, coordination and communication needs, and data collection and reporting requirements, the Network needed basic practical working components to keep it running. This chapter focuses on NISE Net's solutions for administering the Network and communicating with Network partners.

Challenge: How to administer a project with many subawardees and constant change

Constant change is a challenge for a project with many subawardees who, when they finally get up to speed in their roles, suddenly find those roles changing, sometimes in substantial ways. Typically with a grant-funded project, subawardee scopes of work and budgets are defined at the start and remain relatively unchanged for the duration of the project. But for the Network to be successful, it needed to change directions at several points during the project, and that meant it had to modify the scopes of work of individual funded institutions from year to year—increasing budgets and roles
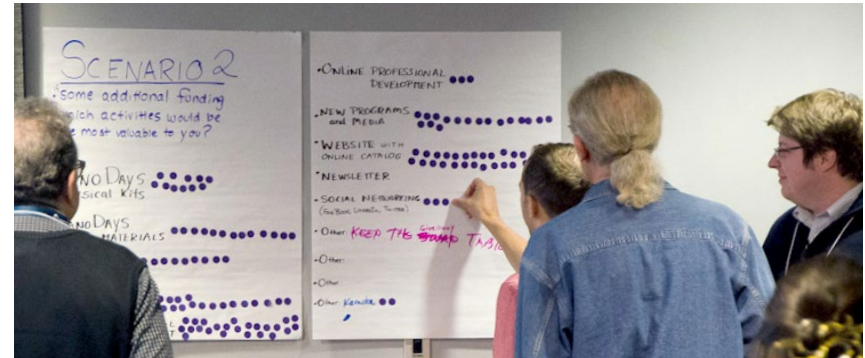
in the project for some institutions while decreasing them at others. Renegotiating scopes and budgets each year may run counter to expectations from previous grant-funded projects.

Several factors made such changes understandable and even accepted:

• Trust and respect for the leaders of the Network and the belief that changes were based on altruistic decisions about what would be best for accomplishing the Network's goals.

• The Network's core principles of learning by doing, flexibility, and responsiveness to feedback and evaluation, which all signaled the value of change over time.

• The practical matter that as a cooperative agreement at the start, budget allocations were approved by NSF one year at a time, and the work of each new year had to be responsive to feedback from NSF's peer review panel.

Even if understandable and accepted, renegotiating budgets and scopes for many partners can be time-consuming and arduous, as well as disruptive to previously anticipated budgets and staff work.

Budgets, scopes of work, and administrative tasks

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LESSON LEARNED:

Building flexibility into the project budget will allow for necessary changes in direction.

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It may be difficult to leave some flexibility in a project budget, especially for funding proposals where there may be an expectation that all of the details would be worked out in advance. But changing course in a project in response to early results may be necessary for success. It could be helpful to allot a set amount in each year's budget that can be reallocated to allow for potential changes that may be needed.

"We established an administrative process that included annual reflection and adjustment of the work for the year ahead, with the understanding that renegotiation of scopes of work would be a part of the process."

– Vrylena Olney, Museum of Science

Subawardees and collaborators on a project are often required to document a commitment to the work in funding proposals. For subawardees this may include detailed budgets for each year of the project. But in order to have the kind of flexibility a project may need, it would be helpful if subawardees and collaborators understood,

accepted, and even supported the idea that roles and responsibilities may change during the course of the project. This is not always an easy thing, especially if a partner's role is significantly reduced in scope as needs change and staff are left without funding.

The funder may require an annual reporting process, and if it is a cooperative agreement rather than a grant, the annual process may require changes based on feedback from the funder.

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LESSON LEARNED:

Creating an expected process for renegotiating budgets and scopes of work with a clear focus on the purpose and goals of the project can help facilitate needed changes.

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NISE Net's particular solution to this challenge included:

• Feedback and reflection on the past year, informed by accomplishments, challenges, evaluation reports, and survey data within various project workgroups and the Leadership Team.

• Leadership Team sets directions for the year ahead and drafts revisions to overall project budget.

• Workgroups plan work for the year ahead, draft detailed budgets for that work within the overall workgroup budget provided by the Leadership Team, draft overall workgroup scopes, and scopes of individual members.

• As each workgroup may include staff of various subawardee organizations, the administrative team pulls scopes and budgets from workgroups into institutional scopes.

• The grant PIs schedule calls with individual institutional representatives to discuss and negotiate proposed changes in scope, especially substantial changes.

• PIs make broad announcement of new directions and changes and how they support project goals.

• Scopes and budgets for the new year finalized and subawardee contracts amended.

LESSON LEARNED:

A range of administrative skills may be needed to support the work of a major project that includes a large network.

NISE Net leadership and multi-institutional management structures described earlier in this document played central roles in running the Network, and in revising budgets and scopes annually to make progress toward project goals. Additional skills associated with various administrative tasks are needed in a large project and may be distributed across several individuals or consolidated in one person. Among these are:

• Scheduling, coordinating, and recording outcomes of virtual workgroup meetings

• Creating and disseminating communications to various groups within the Network as well as the broader community

• Planning and coordinating physical meetings of leaders, workgroups, and the Network as a whole

• Managing project budgets, record keeping, and analysis for decision-making

• Processing subawardee and contractor invoices

• Managing the subawardee contract process including the revision of scopes annually or as needed

• Collecting data needed for project reports including those required by funders

• Developing project reports as needed

• Coordinating between internal and external stakeholders

Intellectual property and branding

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LESSON LEARNED:

A Creative Commons license can facilitate intellectual property sharing.

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NISE Net leadership wanted educational materials created through the project to be available at no cost to anyone who wanted them. And they wanted users to be able to adapt and otherwise modify the materials to match the users' needs. But committing to openly shared resources raises a number of questions among the developers:

• How does the project ensure that rights are cleared, including proper attribution, for content from third-party sources that is used or incorporated into various project materials?

• How would partners developing materials receive credit for their work if everything is openly shared?

• If someone in the project develops an idea that has commercial potential, would they or others be able to proceed with commercial exploitation?

NISE Net leadership decided that the funded partner responsible for developing a product or resource would own the copyright. For example, if the Oregon Museum of Science and Industry (OMSI) created a program as part of a team led by Science Museum of Minnesota (SMM) and through a cooperative agreement subaward with the Museum of Science (MOS), then OMSI would hold the copyright for that program, not SMM or MOS.

While these and other copyright questions could be addressed in a variety of ways, NISE Net leadership decided that in most cases NISE Net products would be made available under a specific Creative Commons license that would allow anyone to use, modify, or distribute a product as long as it was credited, was not for commercial purposes, and the end product would be available under a similar license. Using Creative Commons meant the Network could tap into an existing internationally accepted system, with previously established logos, diagrams, and communication tools.

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CC BY-NC-SA 3.0

Creative Commons License used by NISE Net

You are free to:

Share — Copy and redistribute the material in any medium or format

Adapt — Remix, transform, and build upon the material

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

NonCommercial — You may not use the material for commercial purposes.

ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.

Figure 13. Creative Commons License

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A brand identity can help to identify the products and the broader initiative in a way that individual partner institutional brands cannot.

As a project with many different partners strives to create educational materials of high quality that adhere to specific standards and practices, a method needs to be established for the many potential users of those products to recognize them. Also, if a project recruits a growing number of participants into an activity striving for nationwide impact, it needs a way for those partners to easily identify that activity. As NISE Net is a collaboration of many organizations, the brands, trademarks, and visual identities of these individual organizations were inappropriate for communicating the collaborative efforts of the project.

To avoid an identity strongly connected with any one of the lead institutions, NISE Net hired an independent graphic designer to create a logo and style guide distinct from the logo and styles of the founding partner institutions. The style guide included a logo with a variety of acceptable variations, primary colors, secondary colors, fonts, image use suggestions, and a collection of images. NISE Net then used the same graphic designer consistently across its products. The designer created slideshow templates and document templates that could be modified to create a consistent visual message for presentations and less formal documents. NISE Net developed a web-based collection of images with appropriate releases that could be used in NISE Network materials.

Figure 14. NISE Net and NanoDays logos and materials

The Network also created a standard photo release that would allow images to be used by the organization taking the photo as well as partner organizations. The photo releases that museums typically use don't cover the kind of broad use found in the NISE Network. Images with signed photo releases were then shared via an online photo-sharing service for use by the core project team and publicity photos were shared with the broader Network for their use.

Funded partners responsible for developing products or resources owned the copyrights, but the brand could be identified as belonging to NISE Net. The wide distribution of NanoDays kits was probably the most significant factor in the establishment of the brand, because the physical materials all displayed the branding, and the logos and design materials were provided for partners to use in marketing and creating their own additions to the materials provided.

Although it was never incorporated as a separate not-for-profit organization, after changes in direction implemented in the second year, NISE Net began to feel like a unique organization distinct from any of its partner organizations. This was especially so among the group of individuals in subawardee organizations working for the NISE Net. They all had working group leaders in the NISE Net, often from organizations other than their own, who coordinated and even managed their work. They also developed identities and gained credibility in their own organizations and in the larger field as members of particular NISE Net working groups. They attended NISE Net receptions and events, and sometimes wore clothes in "NISE Net colors" when they gathered.

Importance of communication

Whether starting with three partners or building to hundreds, it's unrealistic to think that everyone will be on the same page without a significant and consistent communication effort.

Before the launch of NanoDays and the regional hub structure, in a survey conducted by Inverness Research of 30 NISE Net participants in funded organizations, over one-third said there was mixed or no "evidence as to whether members of the network share a vision of the identity, purpose, and work of the network and for its expansion" (St. John, 2008). Even among involved partners two years into the project, the big picture of the NISE Net was not always clear.

In a project aimed at getting a large network of individuals and organizations to move in a specific direction, a multipronged communication effort is needed. The NISE Net found a wide range of communication mechanisms useful.

Beyond simple audio conference calls, video conference calls provide a real benefit to team meetings, large conferences, and online workshops. Platforms for this not only allow participants to see presentations or each other, but they may also allow for recording of the session so that a workshop can be viewed later by those who could not attend.

The technology itself is not the total solution to the communication needs of a large project or network. Having the right people participate in the calls is also important to facilitate the flow of information and ideas to all of those who need them to carry out their work.

Some things require more time and a higher level of interaction than can be achieved through conference calls. Those things may include negotiating difficult decisions within a Leadership Team, sharing and reviewing exhibit or program prototypes, learning new skills, or building the connections that hold a network together.

"Face-to-face meetings not only allow partners to become better acquainted, but also provide a medium for mentoring partners and encouraging deeper commitment to and involvement" in the work of your project (Reich et al., 2012).

NISE Net found face-to-face meetings valuable for the Leadership Team, various workgroups, the Network as a whole, and for groups within the larger Network interested in learning new content or skills. NISE Net held Network-wide meetings or regional meetings every year, allowing 300 or more individuals from across the Network to gather, learn, and share ideas.

Presence at professional conferences can provide a face-to-face way for a project to communicate about its goals and strategies to partners and the broader community.

Conference sessions, posters, and pre- or post-conference workshops all provide opportunities for disseminating project learning, recruiting participation, and informing the broader community about the work of the project, resources created, and opportunities available. NISE Net partners organized and presented in sessions at the Association of Science-Technology Centers (ASTC) Annual Conference, the Association of Children's Museums Conference (ACM), the semi-annual Materials Research Society

(MRS) meetings, the annual NSF Nanoscale Science and Engineering Grantees Conference, the Visitor Studies Association (VSA), and other professional organizations focused on science or science education.

Regional hub structure for coordination and communication

LESSON LEARNED:

A regional hub structure can serve as a coordinated communication resource for disseminating project updates and responding to partners' needs.

Having NISE Net Regional Hub Leaders was a key strategy for communication within the Network. Through the hub structure, Hub Leaders share Network information and updates, direct partners toward NISE Net resources, answer questions, and promote the formation of local partnerships, thereby cultivating a sense of regional community. They also provide solutions for building and maintaining the Network, decision-making about distribution of opportunities and resources, and data collection and management.

Having Hub Leaders responsible for geographic regions is a strategy for reducing partner confusion about who to contact for information and help. Over time, NISE Net adopted a strategy where Regional Hub Leaders had responsibility for partners in their geographic regions. The number of regions evolved over time from four to nine, with a Hub Leader assigned for each region.

Regional Hub Leaders who know project directions and grow to know the partners in their regions serve as a valuable resource for both network communication and management.

Regional Hub Leaders can facilitate partner interaction in a network, help museum educators connect with researchers and each other, host regional workshops and meetings, and provide support to institutions in their region. They can:

- act as ambassadors and mentors for network partners in their regions;

- serve as voices in the planning of network strategies and products that know regional partners' needs, wants, constraints, and motivations;

- recruit new researchers and museums to become involved;

- act as matchmakers between researchers and ISE professionals to develop and maintain stronger local connections; and

- facilitate partners' participation in network events, activities, and opportunities.

Throughout the 11½ years of funding for the Network, Regional Hub Leaders continued to recruit new partners for the Network and played a major role in building it up to over 600 participating organizations. They informed partners and potential partners about the opportunities and resources available in the NISE Net, and reminded partners to apply for them. They answered partners' questions and communicated consistent messages about the NISE Net and its work to hundreds of organizations nationwide. They connected partners with common interests or needs that they could assist one another in meeting.

Regional Hub Leaders helped build a sense of community within the NISE Net and made hundreds of individuals feel they were part of the community. Hub Leaders talked individually with partners and reviewed their applications for NanoDays kits, mini-grants, and copies of the *Nano* mini-exhibition. They learned about these partner organizations and brought that knowledge to decision-making processes for awarding kits, mini-grants, mini-exhibitions, and in-person professional development opportunities. They added partner information to the NISE Net partner databases, wrote partner highlights for the NISE Net's monthly newsletter, organized regional hub meetings, tapped partners to give presentations at NISE Net regional and Network-wide meetings, and shared stories through partner blog posts featured in the Network newsletter.

"As a Regional Hub Leader I served as a liaison between the Network and our partners, advocating for their needs and helping to ensure that NISE Net products were equitably distributed to a wide range of institutions."

– Brad Herring, Museum of Life & Science

Keeping primary contacts fully engaged in the activity of a network allows them to be effective in communication and management roles.

Regional Hub Leaders' very active role in the functioning of the Network was made possible by weekly conference call meetings of the Community Group, which consisted of the Regional Hub Leaders and key members of the Leadership Team. These calls updated Hub Leaders on NISE Net plans and activities, coordinated communication by the Hub Leaders to the partners in their regions, facilitated reviews of competitive applications and prioritizing potential recipients, and generally kept the Hub Leaders fully informed and involved in the work of the NISE Net. This was very valuable for building and operating

the Network as it supported clear, consistent messages and well-articulated, agreed-upon ideas and language for communication across the Network of hundreds of organizations.

Ongoing interaction and communication with partners is essential for success in maintaining a network infrastructure.

Because of staff turnover in partner organizations or partners simply being occupied with many other activities, ongoing interaction is essential for maintaining a network. It's valuable to keep in touch and to have more than one contact person at each partner institution. It's also valuable to partners if they have more than one way to remain in contact, as their institutional priorities and capacity may vary over time.

NISE Net leaders and Regional Hub Leaders found a number of ways to maintain contact with existing partners and meet potential future partners, most of which are applicable to any large-scale project. They include:

- staffing an exhibit hall booth at a professional conference
- hosting a conference breakfast
- hosting a late afternoon get-together at a conference
- conducting site visits at partner organizations
- producing a monthly newsletter

• posting on social media

• sending personal and group emails

• using consistent, clear messaging on the Network website

• providing comprehensive, transparent goals for different initiatives

• articulating clear criteria for competitive opportunities

• providing essential information for new organizations and individuals

Online and digital tools

Existing online systems for communication and coordination played a major role in communication across all workgroups and communities in the NISE Net for a variety of purposes. Online collaborative sharing services play a critical role when working together on a large-scale project involving multiple institutions. Major improvements in recent years have made this type of collaboration much easier.

Many institutions already have their own internal file sharing and project management systems; however, we found many of these systems often proved difficult to easily accommodate our Network

due to the user access and permissions needed for large numbers of external collaborators. Managing user access and permissions for different systems and user accounts can be time-consuming, but it is necessary to give access to large numbers of collaborators.

The listing here of the systems NISE Net used is for information only and does not represent an endorsement of any of the specific tools used.

Newsletter:
www.nisenet.org/newsletter
A network e-newsletter for subscribers is an essential communication tool; the newsletter can feature upcoming opportunities and events, partner and resource highlights, and relevant news stories.
Example: VerticalResponse

Video Conferencing:
Used for small team meetings, large project meetings, and online workshops, video conferencing is a major improvement compared to phone conferencing. Video conferencing allows participants to see who is talking, to indicate an interest to speak, and to read body language. It also provides the ability to share documents simultaneously and edit them live. NISE Net used several different services over time.
Examples: Zoom, Adobe Connect

Social Networking:
www.nisenet.org/social
Existing platforms that people already actively participate in can be a valuable way for partners to connect with each other as well as provide additional channels for professional communication.
Examples: Facebook, Twitter, LinkedIn

Photo Sharing:

www.nisenet.smugmug.com

Online photo-sharing sites can be used for the storage of high-quality shareable photos (those with signed photo releases on file), and photos can be made available for broad use under a Creative Commons license.
Examples: SmugMug, Flickr

Video hosting:

Professional development: www.vimeo.com/nisenet
Public: www.youtube.com/user/NISENet

Online video hosting and sharing platforms can be used for both public videos and for professional development training videos.
Examples: Vimeo, YouTube
Video captioning, transcription, and subtitling service: 3Play Media

Calendar:

A shared project calendar can provide partners with access to information about standing meetings and key events in the network, as well as key conferences, to help with scheduling of meetings and events.
Example: Google Calendar

Shared collaborative documents and files:

The ability to collaboratively create and edit files is an essential online tool for shared documents.
Example: Google Docs

Centralized online storage:

Storage and sharing of large digital files and media in one centralized location is another necessity for large projects.
Examples: Dropbox, Box

Survey and reporting tools:

These easy-to-use tools provide a mechanism for submission of online applications for project resources, and for reporting and feedback processes.
Example: Survey Gizmo

Contact Management Database:

Keeping track of contacts and managing key data for reporting is aided through the use of a shared multi-user online database. The NISE Network used a database for keeping track of organizational and individual participation in different project activities (such as applications and awards) as well as individual participation in professional development opportunities.
Example: Quickbase

Mailing lists:

Creating email notification lists for different project teams is a very helpful tool for large projects with changing teams and team members.
Example: Basecamp

"Keeping track of a lot of information about a lot of different network organizations doing many different things is complex and time-consuming, so having a central tool that can store organizational information makes management decisions, tracking, and report writing much easier."

– Kayla Berry, Museum of Science

A database system may be needed to keep track of a large project or network composed of many different organizations doing many different things.

To keep track of information about who worked on the project, what products were developed, what professional development was provided, and what kinds of dissemination events were conducted, the Leadership Team needed information collected from throughout the Network.

The original system for reporting this kind of data was based on partner institutions submitting data to the Admin Team on spreadsheets. This was a very unwieldy system that didn't allow organizations to see what they had reported previously, and duplication of entries was common. The process of combining the data from many partners was tedious, and it meant that the group as a whole didn't have access to the larger picture of collaborating organizations.

NISE Net needed a web-based system that could be accessed and edited by staff from organizations around the country and that would be fairly easy for them to learn how to use. The Admin Team decided to use Quickbase for its data collection and tracking needs. Originally created to collect information for NSF reports so that partners could see what they had reported as well as what other organizations had reported, the database was expanded each year as the Network grew and changed.

Over the first few years, it became apparent that there was a need to collect in one central place information about products developed, the number of public outreach activities run, applications, awards, meeting attendance, etc. As the Network expanded, it also became clear that we needed a way to keep track of contacts at organizations: Who had attended which meetings? Who was involved in the Network? Who had made a contact? Ultimately, it was critical to the overall efficacy of Network activity to maintain a regularly updated database that was easily accessible and comprehensive for the entire Network.

Afterword

Development of the Nanoscale Informal Science Education Network was a unique project due to the sweeping vision for it by leaders at NSF. It allowed for the engagement and commitment of so many talented people from museums and universities for more than a decade. This document presents only part of the story of the collective experience of NISE Net leaders in running this project. The NISE Net website (*www.nisenet.org*) includes hundreds of resources that embody the knowledge developed in this project. Research and evaluation reports document the data collected throughout the project and their implications in connection with NISE Net goals. Educational products embody teachable nano content and ways to engage public audiences in it. Professional development resources, despite referring primarily to nano content, are also applicable to many different science and engineering topics. The next page identifies a number of guides and video resources that can be downloaded from the website.

Partners in the NISE Net, whether engaged Network-wide or locally, are taking what they have learned and applying it to a wide range of new projects and activities. We hope something you find in this document or in the other NISE Net resources online will be useful to you in your own work.

NISE Net Lessons Learned
That Are Discussed in This Document

Intro: A Different Kind of Project

Out-of-the-box challenges and support from the funder over time can make out-of-the-box results possible.

Building the Network: Leadership and Enduring Values

A leadership group with a diversity of strengths and interests can help anchor a network.

A small group of ultimate decision-makers may be needed to tackle difficult decisions.

Enduring core values not only help with decision-making but can also define the Network throughout its lifetime.

Working together in teams with shared experiences can build long-term trust, which is essential for any kind of collaboration.

Partners share ownership and contribute to a network project in ways that members do not.

Diversity of partners—in their experience, context, and interests— from museums and universities can contribute to the success of a network.

Encouraging customization and adaptation to meet the needs of partner organizations and audiences can be enabled through strategies to support quality rather than requiring uniformity.

Learning by doing can be a powerful strategy for innovation and capacity building.

Continually reading the changing conditions, learning from earlier work, and adjusting plans to take advantage of new possibilities can be key to the success of a network.

Evaluating outcomes and soliciting partner input and feedback is important for guiding changes in a network.

New approaches to evaluation can help infuse evaluative practices into all of the work of even a very large network.

Open sharing of resources can facilitate greater use of project products.

Constant Change: Developing the Network over Time

A network structure may need hierarchical components to satisfy funding requirements and facilitate decision-making.

Organizing the work initially into separate, coordinated centers can allow a network project to explore multiple possible directions quickly by drawing upon the diverse interests and expertise in the field.

Capacity and interests of the potential members of the network you are trying to build may require changes in your plan of action and leadership structure.

Independent centers working in parallel on educational resource development may not be a good structure for the coordinated and responsive efforts needed to build a network.

Changing the direction of a massive project may be necessary, but challenging for the people involved.

Setting institutional interests aside may be necessary for Network core partners to lead the Network successfully.

Concerted effort may be needed to build a network around needs that do not initially arise from the network community itself, but rather from the funding source.

Sustainable large-scale public impact may require new efforts once the network is built.

A network can gain the ability to build its own capacity as it matures, even if it is designed to push initially unfamiliar content and practices throughout a community.

Enduring values and constant change are both essential to the success of a complex and challenging undertaking like the NISE Net.

Running the Project: Administrative Processes and Tools

Building flexibility into the project budget will allow for necessary changes in direction.

Creating an expected process for renegotiating budgets and scopes of work with a clear focus on the purpose and goals of the project will facilitate needed changes.

A range of administrative skills may be needed to support the work of a major project that includes a large network.

A Creative Commons license can facilitate intellectual property sharing.

A brand identity can help to identify the products and the broader initiative in a way that individual partner institutional brands cannot.

Communication is key to carrying out a project through a large network where individual actions are expected to add up to a focused whole.

Face-to-face meetings can contribute to a sense of community as partners learn about the project and develop personal connections with others in the network.

Presence at professional conferences can provide a face-to-face way for a project to communicate about its goals and strategies to partners and the broader community.

A regional hub structure can serve as a coordinated communication resource for disseminating project updates and responding to partners' needs.

Regional hub leaders who know project directions and grow to know the partners in their regions serve as a valuable resource for both network communication and management.

Keeping primary contacts fully engaged in the activity of a network allows them to be effective in communication and management roles.

Ongoing interaction and communication with partners is essential for success in maintaining a network infrastructure.

Using existing online multi-user tools can be much more efficient than developing your own systems.

A database system may be needed to keep track of a large project or network composed of many different organizations doing many different things.

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