Narratives in a Science Center: Interpretation and Identity

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ABSTRACT **This paper discusses issues raised by research into people's views of science and scientists, and the implications for interpretative forms in museums. The principles proposed here are based on a series of meetings that looked at the use of narratives in science and the responses of potential visitors from different cultural groups to ideas for narrative signage. Signage design can help people connect to science content by relating practical and theoretical knowledge, crafting explanations, understanding the nature of the medium, and conveying a message about science. The use of narrative form to design experiential guides opens up the possibility of changing a visitor's relationship to the traditional text encountered in museums.**

INTRODUCTION

This paper discusses issues raised by research into people's views of science and scientists, and the implications for interpretive forms in museums. Thinking about the changing nature of knowledge and its relation to people's experiences, we examine the mediating role of museums in general and of science centers in particular. Science centers communicate with the public through narratives that offer an interpretive approach in order to reach diverse audiences.

Science centers, a relatively recent phenomenon, are attempting to redefine themselves, as are museums in general (Macdonald and Fyfe 1996; Sherman and Rogoff 1994; Vergo 1989). However, the experiential side of the specialties they represent does not generally inform discussions about new definitions for museums. (For a practitioner perspective, see ASTC 2004). As educational institutions that are essentially not schools—yet are carefully designed as educational environments—museums are particularly interesting to study. As arenas for potentially powerful learning experiences, they are particularly important to study.

The authors used their experiences as staff members of a science center as the basis for a course in museum interpretation at the state university. The course considered the meaning of museums to the larger culture; how museum insiders decide what their insti-

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tutions mean; and what interpretations their visitors may be constructing. Preparing the course raised many issues about the display of scientific knowledge.

Our consideration of these issues is also informed by a series of discussions and interviews undertaken by one of the authors several years earlier (and described below) for a project called *Using Narratives to Introduce Science Concepts to Diverse Audiences in a Science Center.*[1] There, people from many walks of life discussed their experiences with science, with us, and with each other. The notes and transcriptions for these meetings suggest that, at their core, science centers may be missing both the public interest and the scientist's as well.

The work described here began in June, 1995 with a meeting of five advisors and Arizona Science Center staff, who discussed the notion of narratives and science. The two-day meeting produced notes that were circulated to the participants and were the basis for a planning grant proposal.

Subsequently, a planning grant from the National Science Foundation supported a two-day meeting involving four national advisors, Arizona Science Center staff, and 42 community members who were professionals as well as members of particular sub-cultures. The goal of the meeting was to examine science, and non-science people's experiences and feelings about science, and to discuss whether there was a place for narratives in a science center. Over the two days, the group met several times: first as a whole, then by cultural "interest groups," by profession, and in randomly assigned small groups. Science Center staff took notes at those meetings; plenary sessions were audiotaped and transcribed. Participants were asked to complete and send in a summary of their own experiences over the two days.

About one month after the large group meeting, the local advisors each met for a day with their interest groups. A Science Center staff member sat in. These meetings were held to develop ideas for specific narratives and characters that would appeal to the public. Notes were taken by the members of the group and a written summary was prepared by the group leader. (Methodology is continued in endnotes.)[2]

In asking how the personal experiences of diverse audiences impact on their visit to a science center setting, we examined narrative both as a structure for delivering information and as a tool that people can use to connect to science information. We were interested in the visitor's relation to the sense of authority imparted by traditional interpretive formats. We were also interested, in effect, in relocating authority. Our idea is to identify ways to reduce the alienation that many visitors to a science center may have as learners by developing new forms of interpretive material. As a by-product, we may also be addressing concerns that science professionals have about how their activities are construed and their meanings constructed by the general public.

MUSEUMS AND A CHANGING SENSE OF KNOWLEDGE

Museums are places that interpret the world for their visitors—places of enculturation. As such, they are educational (Bruner 1996). Their collections or exhibits are extracts

presenting or representing the thinking or activity of specific professional domains. The assumption made by museums in earlier days—that a body of knowledge is "out there"—is, however, no longer a given among museum professionals (Hooper-Greenhill 2000). Museum curators and theorists—for the most part unaware of educational or developmental research paradigms of recent decades—nonetheless allow that a body of knowledge may no longer belong exclusively to them.

Perhaps because of the growing participation of educators in museum programming, curators now tend to view knowledge in relationship to an individual's experiences and constructs, and as a process negotiated between the museum and a visitor (Hein 1998; Roberts 1997). As a result, museums have articulated new missions to build connections between their collections and their visitors (Karp, Kreamer, and Lavine 1992; Vergo 1989). Museums of all kinds are changing their displays to be less taxonomic, more conceptual or experiential, more interpretable by the visitor, and more focused on the relation between the subject matter and the visitor (Hooper-Greenhill 1992, 197–215). In short, a kind of Copernican revolution has taken place in the type of enculturation museums do. The locus of meaning-making has shifted from being centered on the museum's body of knowledge to the museum's understanding of its visitor.

Still, the interpretive function of museums means they are recognized as institutions that explicitly enculturate the public into a domain of knowledge or into knowledge-building. Enculturation is about finding identity as a member of your society through activity that confirms who you are (Bruner 1996; Cole 1996; Dewey 1938/1975). In enlisting visitor-centered approaches to exhibits and programs, museums are recognizing that meaning-making is what the experience is about, and they are explicitly helping visitors learn something about themselves as thinkers (Falk and Dierking 2000). In principle, finding identity as a learner should be a strong component of the enculturation-by-museum experience for all visitors. Despite the increasing efforts museums are making to reach out to broader audiences in an attempt to be more inclusive, it cannot be assumed that museums as yet speak or listen to all their visitors (McLean 1999; Sandell 2002).

If a goal is to create personal connections between visitors and subject matter, we have to ask about the extent to which traditional forms of interpretation support people's identities as learners. We need to examine the museum's role in mediating between subject-matter-based concepts and people's experiences, particularly when the subject matter may not have been connected previously to the sense of identity visitors bring to the experience.

In the case of museums that interpret science for the public, the trend is to emphasize the relation between the visitor and the subject matter (Macdonald 1998). Until relatively recently, science was not portrayed as a cultural endeavor and certainly not as a process to be questioned by the lay public. The purveyors of exhibitions were scientists themselves. Science museums of the past aimed to convey information to an uninitiated public; interpretation was equivalent to presenting the scientists' worldview. Thus, natural science museums were established primarily as specimen collections, displaying the specimens in categories that scientists applied in their own analyses. A major shift in display style introduced in the 1920s at the American Museum of Natural History in New

York used dioramas to illustrate specimens of nature in natural settings, causing some controversy (Reynolds 1995).

The history of science, as traditionally presented by museums, has reflected a linear notion of technological progress rather than sets of science concepts or social developments. Exhibitions showed the papers, equipment, and discoveries of various pioneers, and sometimes the setting (office, lab) in which the breakthrough thinking was done. Physical science, like life science, has been presented in abstract categories, via the display of technological devices and explanatory text. Even today, for instance, exhibits in science centers are most often arranged topically according to structural (or curricular) categories such as mechanics, optics, body systems, and so forth.

In newer mission statements, museums of science seek to interest the public in subject matter and to motivate people to learn more about science topics (Association of Science-Technology Centers 1994). They view their interpretive role as one of raising awareness, explaining phenomena, and promoting positive experiences related to the field while being committed to presenting what the scientific community accepts as legitimate practice. The hands-on nature of the scientific investigation and its power to encourage visitor interest have led to the advent of science centers as well as to the introduction of "interactives" in established science museums. Hands-on science centers are now found in every major city, as well as in many small communities. In the last 30 years, over 450 centers have been built in the U.S. and over 800 worldwide. Awareness of the importance of understanding the workings of the natural world has led to an emphasis on exhibitions showing visitors the relevance of scientific developments. The Smithsonian Institution, in its *Science in American Life* exhibition, for example, presented a critical history of scientific developments in the U.S., focusing on controversial areas such as nuclear energy and weapons technology, asking visitors to question the value of such "progress" (Molella 1997).

In recent years, the cultural nature of science and considerations of how people actually learn science have been addressed in exhibit design. In one exemplary project, the Children's Museum of Indianapolis created a science gallery based on developmental learning principles as well as science concepts (Schauble and Bartlett 1997) and included planning for the role of floor staff in mediating visitors' use of the exhibits. Science as a social enterprise with significant ethical components is being addressed in exhibits and programs as well. Science centers such as the Exploratorium (Klages 1999; McLean 1999), the Birmingham Museum of Science and Industry (Baldock 1995) and Science World in Vancouver (Pedretti 1996), for example, have experimented with presenting scientific processes and social issues as organizing themes. The point of view of the public in those exhibits is recognized as a prominent part of the dialogue about scientific progress today.

A CHANGING SENSE OF INTERPRETIVE AUTHORITY

Museums that interpret science today aren't invariably connected with research institutes. They don't do science; they represent and interpret science. Generally, the staff includes people who studied science and sometimes people with advanced degrees in sci-

ence. Science centers also generally maintain close connections to universities, research facilities, science-related agencies, and advisors in order to stay informed.

A science center is a special place to think about and enjoy science. It suggests that scientific principles are at work everywhere, but we need to take them out of the everyday in order to experience them. Science centers emphasize the relevance of science for people and the intrinsically interesting questions scientists study. In doing so, they remove science from home, school, and lab alike. Instead, a fourth reality is established that is neither everyday nor academic, but still educational and authoritative. Those who provide this informal interpretation of science have considerable authority to speak to the public about science. Consider the recent media attention given to the Rose Planetarium of the American Museum of Natural History in New York, when it announced that Pluto was no longer to be counted among the planets (Chang 2001).

Museums have a variety of ways to support meaning-making through the arrangement of space, exhibits, visitor experiences, and educational messages. Because museums' relation to their own historical tools of interpretation is changing, it's possible to bring new creativity to interpretive design in order to be more educationally effective. In science museums, viewing collections and reading expository text labels have traditionally been the ways in which a visitor encounters subject-matter content and its interpretation. But these traditional forms of display and activity may not be able to adequately convey messages about the visitor's relationship to a science museum's contents. "One of the major anxiety factors surrounding a museum visit... is what we call the 'numbskull factor.' Mountains of facts can make a person feel dumb. Feeling dumb is inhibiting" (Storad 1997). What people are willing to take as explanation and what experts are trying to teach may not be congruent with the existing tools and techniques of museum culture. In addition to the need for a new type of mediation, there is a need to examine the psychological and socio-historical reality of the way meaning is constructed with the tools science centers have to offer.

The simple museum model of the transfer of knowledge from expert to novice is no longer an acceptable vision of how people make meaning (Roberts 1997). On the "novice" side, the public is less willing than in the past to simply accept the voice of museum authority. On the "expert" side, displaying a linear understanding of science without the chaos from which it arises obscures the reality of scientific endeavor. So, for example, in our discussions, one scientist said:

> I find it very curious that over the past 200 years or perhaps 2000 years that there's been a tendency to say that what is science is linear when, in actuality, science is just a word that attempts to describe human perception and account for those perceptions and document those perceptions in terms of linguistic and syntactical style, and it varies from culture to culture (ASC 1996, 3).

In other words, science is the activity of seeing patterns in what appears to be randomness. That process is the aesthetic and intellectual beauty that the public often misses.

People want to see their concerns and issues reflected in science centers. Scientists want to see the creative side of making order from experience, which their work reflects. Meeting on common ground, science centers need to facilitate dialogue that overcomes the alienation of each perspective. The question is: How can this dialogue be achieved?

TRADITIONAL AND NEW INTERPRETIVE FORMS

Innovative ways of organizing subject matter for public understanding have been attempted quite dramatically in non-science domains. For example, the Holocaust Memorial Museum in Washington, D.C. presents a historical record in the form of an emotional "immersion" experience (Linenthal 1995). Visitors are asked to identify with a specific individual and follow that person's fate as they proceed through the galleries. Historical Williamsburg organizes a site in the form of a re-enactment with interpretive commentary (Gable 1996). When the perspective of the slave population was added at Williamsburg, the result was so powerful that it caused controversy among staff as well as visitors. These interpretations are predicated on a story form, a narrative vehicle through which the visitor learns.

In science centers, information is generally presented through hands-on devices and graphics, text, or audiovisual material. (Static display of objects is still common, also). Immersion, virtual reality, and audience participation are some of the newer techniques being explored to heighten the experiential nature of the visit (Farmelo and Carding 1997; Ucko 1999). Some exhibitions have enabled visitors to add their own commentary, either in writing or on tape, and make the comments available to other visitors for reviewing. An example is the exhibition *What About AIDS?,* developed by a consortium of science centers. Visitors added their comments and memories to a guest book, which provided an opportunity for personal reflection and engagement with the exhibition (Toon 2000). Some exhibitions, like the Exploratorium's presentation on memory, have used prepared commentary from people.

A few exhibit designers try to do away with what is called "signage" associated with science exhibits, much the way some art museums insist on minimal labeling of artwork in order to "free" the visitor to experience the work directly. As one cultural critic notes, "The ideal gallery subtracts from the artwork all cues that interfere with the fact that this is 'art'" (O'Doherty 1986, 14). This is not, by any means, a uniform practice or approach. But in most science centers, signage is still the most important device available to help the visitor understand the exhibits. And signage does make a difference in what people learn (Falk 1997). Text, graphics in various forms (such as charts, icons, symbols), and labels are critical tools of interpretation (Serrell 1996).

Although these mediational devices vary in design and function, for the most part the material they refer to is manifest or visible. Signage, for instance, explains exhibits and tells visitors what is expected of them. Signage tends to focus on the exhibit content and not on the visitor, although it may ask visitors to draw on their experiences (with wording such as "To do and to notice," "Notice how..." or "Can you discover...?"). Signage sends a message about the role of the learner, usually one that says: You are a

novice and require direction and explanation from a non-present expert in the form of written text; success consists of connecting your activity at the exhibit with the principal explained by the text. An exception is participatory signage that begins to include the visitor in the dialogue. In exhibits departments, teams of specialists work hard on crafting words that provide clear instructions, simple directions to provoke thinking and questioning, and concise descriptions of key ideas.

Much research has looked at how well signs work in museums to direct or inform (see Bitgood and Patterson 1993; Serrell 1996). To evaluate the current effectiveness of science centers as educational institutions, however, we need to first examine the meaning of the signage. If science centers are trying to say that it's the experience—not the object in front of you—that is important, then the traditional relation between visitor and signage needs to change. Text is not simply text; some of the material that signage communicates is unstated or non-manifest. Furthermore, as Hymes says, "a written document may be dependent on knowledge of non-linguistic context for its interpretation just as speech may be" (1996, 113). Thus, in order to analyze museums as learning environments, it is important to look at how signs convey meaning. What do they say—by their placement, design, and language—about how the museum regards science?

Previous research suggests that people do indeed bring their own interpretive frameworks with them to a museum and negotiate meaning through the mediation of the museum's collection (Doering and Pekarik 1996; Silverman 1990). A clear question for science centers in organizing and developing signage for public understanding is whether exhibit interpretation should start from the way science is organized, or from the ways people think—or from some other starting point. Right now, most museums suggest that science's explanatory categories are how the visitors should organize their thinking.

Research in schools—as well as recent commentaries about the museum experience—refer to the role of narrative in learners' construction of meaning in various settings (Cortazzi 1993; Bruner 1990; Hymes 1996; Thompson and Tyagi 1996). Descriptions of teachers' and students' discourse, moreover, show that people tend to organize their experiences into narratives in order to better make meaning from them (Cortazzi 1993; Hymes 1996). Story grammar, for instance, is a universal and facilitative form used to recall everyday information (Mandler, Scribner, Cole and DeForest 1980). For these reasons we were interested to hear about our audiences' own experiences with science. Through narrative, the traditional authority-novice model is transformed to one of dialogue, with the speaker authorized by experience.

Our discussions on narrative raised questions as to whether mediating devices organized around abstractions such as curricular category systems may actually inhibit many visitors from deriving personal connections to and meaning from the science content in exhibits because the organizing principles do not reflect a familiar or everyday form of meaning-making. These devices, furthermore, may not adequately represent the scientific enterprise itself because of the authority of the expository form. If so, we need to inquire whether there are mediational structures that can bridge scientific principles with intuitive ways of organizing information mentally, such that personal identity is preserved and even strengthened.

LISTENING TO NARRATIVES

At the Arizona Science Center, we wondered whether the traditional format of signage communicates something about science center content and experience that visitors do not find personally meaningful. Would a personalized view of science have visitor-created signage? Would it ask for different emotional and intellectual responses from the visitor compared to, say, an art exhibit? Can the ways in which science centers talk about science or engage visitors in science-related activity lead to any personal insights about oneself as a science learner?

To explore ideas for new meanings and tools in science center exhibitions, educational staff at the Arizona Science Center considered supplementing a traditional suite of science exhibits with materials organized in narrative form, to look at how individuals from different cultural groups respond to them.

First, however, we had to listen to people's own narratives. To see if and how scientists and others may differ in their thinking about science experiences and science centers, we asked advisors and members of communities who are under-represented in advanced science classes and technical professions—minorities and women—to a series of discussions to help us identify the issues of personalizing science. The first discussions took place in 1995 over two days, with a group of five advisors, including a nature writer, an educational researcher specializing in reading, a television science show producer, a bench scientist, and a master science center interpreter.[3] That meeting encouraged us to invite an even wider group to discuss some of the notions that were put forth.

Methodology—With a planning grant from NSF, we convened a two-day conference in 1996, inviting four national advisors (a learning psychologist, a science educator, a physicist, and a historian) to join a larger group of local specialists in education, the arts, writing, and science.[4] These local specialists represented six different "interest groups": women, Hispanics, African Americans, Native Americans, people with no technical background, and people with physical disabilities.[5] During the plenary conference, participants met in groups by profession, by interest group, and in random mixes at different times. A month later, each of the interest groups met for a day by themselves (except for the group of people with disabilities, who agreed they were not a subculture; each member joined another group with which s/he felt more affinity).

Discussions were open-ended. Only plenary sessions were audiotaped. The meeting was not considered a study but, rather, a gathering of ideas. Essentially, we asked all the participants to discuss and compare their experiences with science. We asked them to develop ideas for characters and stories that related to their experiences with a particular science topic: energy. Later, with some remaining funds, we took their ideas to members of the public and collected reactions. We then created some prototype interpretive materials and reviewed them with even more members of the public. Some results of the investigations have been reported elsewhere (Martin and Leary 1997a, Martin and Leary 1997b). Below, we discuss the findings as a basis for developing design principles for interpretive materials.

ALIENATION FROM SCIENCE

A sense of personal distance from the domain of science was clearly noted among some participants in the two-day plenary group meeting of 46 scientists, science educators, science writers, creative writers, artists, and performers of many ethnic backgrounds. One woman, a creative writer, said: "If I encountered science, it tended to feel like I was being told [my ideas] aren't right: you've constructed the world on a private, mythic level for yourself...." As one Native American science educator noted:

> The word "science" has an image problem. . . . Everybody loves nature and, not to be extreme, everybody hates science. Those teachers in elementary schools say: "We're going to increase the science content in your classrooms." They imagine cutting up frogs. They imagine scientific bunk or other crazy words. We have to bring nature and life back into the work we're doing (ASC 1996, 14).

A distinguished physicist, known for his engaging popularizations of science history and discovery, began the discussion about narrative by identifying seven different genres (biography, history, stories where the science itself is the drama, and so forth) through which science stories can be told. Whether in response to the fact of a list or to the categories in the list, other non-scientist members of the group challenged this organizing system. One Hispanic creative writer and professor said, ". . . the first thing I would do is reject [the seven genres] because I don't want to know how it's been done." He proposed a "fusion" of meanings:

> . . . [A] science of imaginary solutions. . . . We are restrained from that because we're being told all things that science does. . . . You've already given us this paradigm of "wow" and "ah-ha" but you left out "oh yeah, I knew that. I just knew it *this* way. I knew it through some other talent." One of the things which was most intriguing to me about science is its—what I would call—situational physics or emotional science, or science of the moment, where somebody has tried something and they know it works. It worked for them and they will believe all the rest of their lives, and that is their science. And that humanness is what we're trying to keep in common (ASC 1996, 8).

Consistent with forms of recent postmodern biography, literary criticism, and historiography, the non-scientist advisors felt that new forms of expression are needed in order to bridge their personal experiences with science. "Demystifying" science was an important outcome for many. For example, non-scientists in our women's interest group uniformly felt the story of science didn't relate to them; they described science as a "priesthood." They suggested that memoirs, accounts of how scientific discoveries were made, personal journeys, and information about various insights that broke paradigms would be of more relevance to them. These turned out to be relevant to the scientists as well.

Native American project advisors, hearing the observation by a science educator that "science is a special way of telling a story," strongly disagreed. They felt that taking

nature out of context destroys its story. "The notion of a science center and your thinking about science just doesn't make sense to us," said one tribal environmental educator (ASC 1996, 4).

Forms of narrative in native communities are likely to be in traditional format (for instance, fables) and may be presented as responsive dialogue between storyteller and audience. Another kind of nature lesson for many Native Americans is traditionally conducted while working at the side of an older tribe member—for instance, while herding sheep. Several people recalled walks with their grandparents in which lore and knowledge about the landscape was imparted to them. In effect, science centers don't make sense to Southwest tribes because science centers are quintessentially de-contextualized nature and because the explanations they offer are not seen as tied to human experience. "'Science' is about the roots of where we come from," explained one Navajo educator. A Native American storyteller said:

> When I was a little boy I was confused as to what science was in the classroom. But when I got home, my grandparents spoke of the same things and showed us how to respect, understand and to be about life in the simplicity (ASC 1996, 12).

A Native American science educator said:

> And when our brother here comes and talks about it, he learns science in class and goes and Grandma tells him, "Yeah, that's life." That's the way I was taught. That's what we have to reclaim. We have to reclaim the nature in what we're doing and find ways to translate that into scientific narrative (ASC 1996, 14).

The consensus was that personal narratives are a good idea for getting people to think about science: "Let's not think of cultural narratives and science as strange bedfellows, but as a long overdue combination of energies." "Narrative in my mind includes an experience about life. Science is life!" "Narrative teaches and engages—I want that for science."

The stereotypical idea of science is a set of truths that exist beyond gender, ethnicity, and so on, and that cannot be contextualized. The advisors' comments, however, raised the question of whether or not it is *through* gender, ethnicity, and culture that science knowledge can be accessed.

> When we tell stories about the sun, we look at the child at a very individual level. This child is at this developmental level and is ready for this particular type of story, whether it's a blessing or protection way, whether it's a male version or a female version of it, depending on where they're at. How would we know where people are at in terms of receiving the stories we are creating? (ASC 1996, 20).

At various times the scientist advisors said:

> Most people in the sciences don't talk about science, they talk about nature. Science is a way of looking, exploring, and communicating (ASC 1996, 12).

> I was just talking about limiting possibilities or limiting the imagination. Isn't science about making leaps of knowledge, just the same as poetry is? (ASC 1996, 13).

The practicing scientists and science educators at the meeting also felt the human side of their activity is neglected in the stereotypes: "Life is a story! Everybody has a story about love and the good things. Science is a process of dramatizing life experiences" (ASC 1997a).

In the month following the two-day plenary session of advisors, each of the five interest groups met by themselves with Arizona Science Center researchers, with the charge of refining ideas they had begun to develop for characters and scenarios for narrative material related to the topic of energy. Over a day, they reviewed what they wanted to achieve and discussed what narrative elements would be most meaningful in order to speak to people like themselves who don't see themselves as science-oriented. The historian said:

> What I think needs to be brought to bear on these issues are people's experiences, people's traditions, people's cultures. How people view science from different perspectives. Not only the issue of gender, how men and women interpret, how we learn science, but also people coming from different cultural traditions, be they Hispanic, African American, Native American, Asian American. How science plays a part in their lives. How culture is very important. That the stories we learn, we grew up with, the experiences we have are traditions, are cultural traditions, which involve language, religion, and a number of other things, are very important in the writings of scientists, in writing and learning about science (ASC 1996, 4).

The groups came up with sketches of protagonists who could serve as narrators and with topics for those characters to recount. The women's interest group, for instance, suggested developing a narrative from the point of view of a pioneer woman who had settled in Arizona during territorial days. This character would talk about how she coped with the heat back then. The Hispanic group suggested creating the character of a gardener talking about her strategies for planting a desert garden. The African American group developed the concept of an animated photon, Ray-Ray, who would undergo rites of passage as he traveled from the sun and met various "cousins" by transforming energy states. The Native American group proposed a grandfather character who would tell a tale about the land and the importance of the sun. The "people with no technical background" group proposed having a car mechanic give advice and explain the science. Other characters were suggested —13 in all—including a nosy but knowledgeable neighbor who had a lot of practical advice to offer; an African chief who would share stories about the significance of the sun in different cultures; a handicapped woman detective

who had a MacGyver-like approach to problem solving; a pair of precocious children; a retired physicist couple (Albert and Marie), who could recount changes in understanding that had occurred over their lifetimes; a rapper/poet who breaks down jargon in music; an early explorer of the Colorado River; and a mother-in-law who offers sage advice.

DESIGN PRINCIPLES

For the character ideas generated by the interest groups, we chose images of what such characters might look like and wrote a few paragraphs describing them and what they might recount in a narrative. We then interviewed 92 people in small groups from a variety of backgrounds to get their reactions to hearing a story from the 13 different narrators, and to ask about how stories could be presented in a science center setting. In the third phase of our exploration, we commissioned three written narratives, and we selected a published story.[6] We had actors record them on audiotape and then tested them with more members of the public.

As reported elsewhere (ASC 1997b), members of the public found much to relate to in these characters and their stories, albeit to varying degrees. For example, they reacted negatively when the stories were seen as too "politically correct." Sometimes, a story or narrator was judged as acceptable but for a demographic characteristic different from themselves. These and other reactions to the characters and the prototype narratives about energy topics offered us some clues about how personal identity and explanatory form may interact, and they pointed to several key design considerations for developing narratives as mediating materials in science centers.

Integrating authority and authenticity—It seems that authority and authenticity are a meaningful aspect of the interpretive voice we are proposing. According to our interviews, those with little technical education background often consider science to be populated by unwavering authority figures. However, when asked to review ideas for story narrators, members of the public tended to prefer authoritative figures to ones they perceived as everyday—that is, people like their neighbors, or children. Similar to findings from other research about character appeal (Research Communications Limited 1991), people seemed to want to hear about science from grandparent authorities: figures who are uncritical, wise, and protective. An exception was the pair of retired physicists, who received mixed reactions; somehow they were perceived as dated rather than experienced. ("They remind me of snowbirds," said some senior winter residents of Arizona.)

A degree of authenticity was also demanded. The integrity of the preferred narrators rested on the fact that they seemed to have lived through a lot, could have seen scientific developments in their time, and could have experienced them directly. The device of having narrators reflect on their own experience was an important characteristic for our public. Being too "everyday" lost you authority. One proposed character, the "car mechanic"—described as having a lot of technical know-how—was rejected as a legitimate narrative voice. Also rejected were a neighborhood gossip ("el chisme") and the

mother-in-law, both of whom were described as having common-sense ideas. These characters were rejected as untrustworthy sources of information about energy, based on people's own experiences with such types of individuals. Ultimately, the narrators preferred by a majority of members of the public were the Native American grandfather, the African chief, and the homesteader, followed by the animated photon, the explorer, the gardener, and the detective. These were people seen as "wise," those "who really lived it," who were "interesting" and "respected."

Relating practical and theoretical knowledge—Previous research in schools suggests that when a teacher helps students insert examples of a narrative problem from their own lives into an analytic frame arising from a generic textbook example, students' understanding of the abstract point of a lesson is greatly facilitated (Martin 1987). Either extreme—using narrative examples that were too abstract, or that never went beyond personal anecdote—did not offer a good base on which to build conceptual thinking.

In this case, the preferred informative voice was benevolent as well as believable, yet people were more comfortable when the content came from the real world. When we asked members of the public for projections of what their favored characters would have to say about energy, most of the suggestions had to do with explaining everyday phenomena rather than explicating causality or underlying principles. People reported being comfortable with scientific material when it is framed as "nature" (as opposed to "science") or as a topic affecting their personal lives—for instance, workplace health hazards. They were interested in hearing how a garden grows in the desert, how homesteaders kept cool before air conditioning, and traditional native practices for harnessing the sun's energy. People responded positively to scenarios that were read to them about applications of energy in daily life.

Craft and explanation—As may be expected, language, including structure, vocabulary, and voice, is a big part of people's sense of identity (Hymes 1996). One creative writer said:

> [C]ertain considerations, such as language, are not simply proposals but imperatives.... Language is the key to [the] issue of a museum; language is information; therefore, language is the key to succeeding (ASC 1997a).

Several of our informants spoke about their alienation from scientific language, specifically from the objective stance of science and the use of technical terms. Discussions about writing returned to issues of genre and culture. The consensus was that story format is critical to creating personal connections. For example, the Hispanic writers explored familiar narrative forms in their community. Thinking of the "cultural icon" Super Barrio, who stands up for the people, they imagined that "he started showing up in different places. We can see this in a science context, that there are places where science needs to be instead of where it simply is." They saw him as appearing in different guises. And then, "it came to us, that in terms of our storyteller, we don't necessarily see it as a single storyteller" (ASC 1996, 16–17).

One of the women writers commented on science fiction:

> I have a problem with science fiction being called too often misleading . . . women's science fiction writing, that is attempting to narrate out of the dogma or even probability of our prescribed realities . . . which are misogynist sometimes. . . . So as narrative is pleasurable misreadings, science fiction can be pleasurable misleadings. And isn't that what we want to do? Think toward possibility? Isn't that part of science and discovery? Science fiction has a place (ASC 1996, 13).

The science journalists felt they needed to re-examine what they always regarded as straightforward accounts to see that they weren't preaching to the converted. The members of the public who reviewed the story ideas (in ethnically diverse groups) reported that they would enjoy a range of genres of science stories, including mysteries, quests, problem-solving scenarios, and native teachings.

In the final phase of the study, when we commissioned creative writers to write short narratives related to the topic of energy from several characters' viewpoints, the pieces they wrote were episodic and literary but not strongly dramatic. We tested the appeal and memorability of the sample stories by having groups of people listen to audiotaped readings made by an actor. We found that events alone, or a string of events, though gracefully expressed, are not enough to interest most people. Form and style received the most comments. For example, the homesteader "sounded like social studies lessons." Other comments described the various texts as: "too poetic," as having "jargon," "sounded too religious," "weak voice," "pace too slow."

In sum: Text that individuals can enjoy and engage with is not offhand and everyday, nor is it textbook- or teacher-like; it is artful but not simply literary. Like other educational narratives, science stories need drama and structure. They must be crafted into special cases of narrative that are themselves an abstraction of personal experience.

The medium—The medium of text carries a message. As Martin has argued elsewhere, particular media have their own cultures, with consequences for learning (Martin 1987).

From our group interviews with the public, we have reason to believe that written text panels in a museum setting are viewed as off-putting. Other traditional delivery formats for stories—including written text, audio, and pamphlets—were not attractive to people in the context of a science center. Theater and video were more favorably viewed as delivery systems. Interestingly, people were most excited about new technologies such as interactive compact disks and virtual reality, and recommended that we make use of new formats to present narratives. They saw the use of new technology as more consistent with the notion of a cutting-edge science center—an interesting clue that media are experienced as cultural tools and can have mass appeal, or, perhaps, mass meaning.

The message about science—As it turns out, scientists themselves may benefit from a review of the explanatory methods of museums. Those we worked with on the project evidenced some skepticism during the discussion on stories, but all of them reported that

they got new ideas after the discussions. They also expressed impatience with popular images of science as a collection of facts and answers conveyed by mad scientists. They saw limitations with curricular or taxonomic ways of communicating to the public. What they learned was that narrative is a form in which they could communicate more current meanings of science—meanings that better reflect the scientific enterprise in which they are engaged. These include messages about description, change, continuous questioning, spiraling discoveries, personal journeys and enlightenment, and the social responsibility of humans as stewards of the earth. So it seems that introducing narrative signage in a science center might solve one communication problem, because science itself no longer views itself as "objective" and immutable in the stereotyped ways that traditional forms of signage seem to express. One scientist noted:

> There's been a gross acceptance of that [science's] formalism. One label you'd use is physics, another label is general science. But it's that formalism that we have a convention for, specified in a given culture. And I think that sometimes the way we talk about science in the nineteenth and twentieth century is we tend to talk about science as a dogma. We don't talk about science as a technique. We don't talk about science as a representation of perception. We don't talk about science as a convention of documentation. . . . We talk about science as if it were a religion. And I think that, in many instances, alienates people to science. The conventional approach is to say "that's right" and "that's wrong." That's the religious aspect of it. Whereas if we talk about science as a formalism, it allows for the fluidity, it allows for an exchange, it allows for an interaction because we see it as a technique. We see it as a way of saying we as a group have this awareness. We as a group have adopted this notation. That's different from faith. That's different from dogma (ASC 1996, 9).

CONCLUSION

Science centers have a good deal of work to do in developing interpretive materials that speak to visitors. There is an art to effective communication of content in museums. Because definitions of knowledge have changed, museums must focus on the learner in non-traditional ways. In science centers, a label text may speak in the voice of alienating authority to visitors who may already feel estranged from science. If visitors do not hear familiar voices, and if the voices do not speak in subtly reassuring tones, they may mentally disengage with the content of the message. They may stop extending their minds—visualizing, attending, and calculating—and so fail to create meaning. Interestingly, the modern scientist's voice is not recognizable in traditional forms of signage, either. It is not that the truth and claims of science need to be altered; it is that the ways in which knowledge and scientific activity are imparted may need to be.

Because of visitors' demands, museums are obliged to acknowledge points of view other than the curatorial one. In fact, it has been argued that unless the museum explicit-

ly talks about its own interpretive role, there is a risk of provoking public outcry (Riegel 1996; Toon 1997; Wallace 1996). In a history museum, the issue of shared interpretation may be more easily addressed. In the case of science centers, everyday explanations and theories are rarely acceptable. Cultural perspectives are seldom acknowledged, although many visitors do not feel part of the science culture represented in museums. The question is whether science centers could adopt an explanatory framework somewhere between the "objective" end of the spectrum represented by the field of scientific inquiry and the many truths of visitors' experiences.

The idea of using narrative form for designing experiential guides opens up the possibility of changing a visitor's relation to the traditional kind of text encountered in museums. Narration seems to correspond to the intuitive way people organize their thinking and validate their experiences in relation to external events; it is a form that does not set up opposition between everyday experience and underlying scientific concepts because it is reflective. It also could highlight the patterns of nature and how different generations impart them to younger members.

To make the educational resources of science centers truly accessible to the public, and to reflect to people that they are indeed learners of science, a lot more experimentation with mediating devices such as text is needed. It would be useful to describe how a specific set of narrative materials mediates the activity and mental engagement of diverse learners in a science center. We need to develop and study narratives that meet the criteria we identified for creating bridges between scientists' truth and the public's perceptions: benevolent, authentic, everyday, artful, high tech, and personally cultural.

Studying the relationship between identity, enculturation, and learning always remains a challenge. As museums, science centers, zoos and nature centers, and other institutions of so-called informal education begin to be studied by those interested in museum learning, identity, and narrative, perhaps this discussion will contribute to further dialogue.

NOTES

1. NSF No. ISE-9554473.
2. Paragraph descriptions of the story ideas were written by researchers based on the interest group notes. The researchers also selected photographic images from magazines that could represent the characters of each story idea, 12 in all. Four focus groups of 12–15 people were recruited from companies represented on the Science Center Board. The groups included a mix of the target cultural group members; all members had school age children. Interviews were conducted at the business sites. Participants received refreshments and passes to visit the Science Center. At these sessions, the ideas for narratives developed by the advisor interest groups were reviewed for appeal. The researchers then narrowed the list down to the most popular ideas. Because there were funds remaining from the planning grant, we were able to commission four scripts from some of the creative writers in the interest

groups. In the case of the Native American narrative, the author was not able to complete the assignment so we used the text of a published children's book. A professional actor was hired to record the four narratives on audiotape. These tapes were played to four additional, ethnically mixed parent focus groups. A short recall test was conducted after each hearing and appeal was discussed. Notes from both sets of focus groups were taken by a staff researcher and the comments summarized.

3. Lawrence Cheek; Isabel Beck, University of Pittsburgh; Samuel Gibbon, Alfred P. Sloan Foundation; Susan Wyckoff, Arizona State University; Eddie Goldstein, Denver Museum of Nature and Science.
4. Vera John-Steiner, University of New Mexico; Mary Budd Rowe, Stanford University; Hans Christian Von Baeyer, College of William and Mary; Pedro Castillo, University of California, Santa Cruz.
5. A non-scientist leader for each group was invited by the Arizona Science Center to form a committee of colleagues representing the different fields of expertise.
6. The narratives were about Ray Ray, a pioneer woman, an Hispanic woman gardener, and a Native American origin myth.

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