COMMUNICATING *CONTROVERSY:*

SCIENCE MUSEUMS AND ISSUES EDUCATION

BY ANN MINTZ
FOR THE
ISSUES LABORATORY COLLABORATIVE
WITH A SURVEY BY
MINDA BORUN AND MARGARET CHAMBERS

ASSOCIATION OF SCIENCE-TECHNOLOGY CENTERS
WASHINGTON, DC

PREFACE

The Issues Laboratory Collaborative is a National Science Foundation-funded project (Project MDR-9153964) in which five science museums joined together to investigate effective ways to present issues in science and technology and to share what they learned with other centers. Each member of the ILC developed and evaluated a presentation that explored various aspects of the same topic, global climate change.

Each program employed a different format. Discovery Place in Charlotte, N.C., developed an interactive, cart-based demonstration; The Franklin Institute Science Museum in Philadelphia, Pa., produced a participatory video presentation; the Museum of Science, Boston, Mass., developed a public-policy lecture and demonstration; the Orlando Science Center in Orlando, Fla., developed a science theater presentation, and the Oregon Museum of Science and Industry in Portland, Ore., built a free-standing exhibit kiosk. Front-end and formative evaluation guided the development of these presentations. Two components, the discovery cart and the OMSI exhibit kiosk, were presented and evaluated at each ILC venue.

Specific products developed by the ILC are available to all ASTC museums. They include scripts, prop lists, and set plans for theatrical presentations; scripts and plans for free-standing demonstration carts and video productions; videocassettes; and evaluation results. The ILC Catalog is available from:

Issues Laboratory Collaborative
Franklin Institute Science Museum
222 N. 20th St.
Philadelphia PA 19103

Serious consideration of the role of issues education in science museums raises profound questions. To explore these questions, the ILC hosted an invitational conference in Washington, D.C., January 22-23, 1994, and conducted a three-site study of visitor attitudes about issues exhibitions and programs.

Sponsored by NSF, the conference was organized by the five partner museums listed above. The following report is based on discussion during this event, and was written by Ann Mintz, co-principal investigator of the Issues Laboratory Collaborative. Roree Iris-Williams and Minda Borun served as the other principal investigators. Unless indicated otherwise in the body of the report, all conclusions are drawn from the conference discussion.

The results of the three-site study, conducted by Minda Borun and Margaret Chambers with assistance from Beverly Sanford and John Shane, follows the conference report; the study provides data that shed a different light on the topic of the ILC conference and offer exhibit developers and public programs staff a clearer sense of visitor interest in and acceptance of controversial material.

Participants in the conference:

Juanita Hernandez Black and Ann Mintz,
Orlando Science Center,
Orlando, Fla.
Joel N. Bloom and Minda Borun,
Franklin Institute Science Museum,
Philadelphia, Pa.
Chris Burda,
Minnesota Children's Museum,
St. Paul, Minn.
John Falk,
Science Learning Inc.,
Annapolis, Md.
Graham Farmelo,
Science Museum,
London, England
Roy Gould and John Shane,
Museum of Science,
Boston, Mass.
Roree Iris-Williams,
Garden State Discovery Museum,
Cherry Hill, N.J.
Ann Muscat,
California Museum of Science and Industry,
Los Angeles, Calif.
Wendy Pollock,
Association of Science-Technology Centers,
Washington, D.C.
Beverly Sanford,
Discovery Place,
Charlotte, N.C.
Beverly Serrell,
Serrell and Associates,
Chicago, Ill.
Nancy Stueber,
Oregon Museum of Science and Industry,
Portland, Oregon

COMMUNICATING CONTROVERSY

SCIENCE MUSEUMS AND ISSUES EDUCATION

Science museums mirror their times, reflecting changing attitudes towards science and technology. Historically, science museums evolved in parallel to major developments in society. The Industrial Revolution inspired industrial expositions glorifying technological progress. The rise of the middle class led to the establishment of an array of new educational institutions. Both expositions and educational institutions are ancestral to the hands-on science-technology museums that were to develop in the first half of the 20th century.

Where the late 19th century glorified technology and industry, the 20th century celebrated science. The "wonders of science" was a common theme in institutions such as Philadelphia's Franklin Institute Science Museum and the Museum of Science and Industry in Chicago. After World War II, science museum exhibits explained how things worked to a "do-it-yourself" America, and celebrated the wonder of the science that was transforming American life.

By the late 1960s, science no longer seemed unequivocally beneficial. Concern over the environmental consequences of technology had grown, and the oil shortage of the early 1970s underscored U.S. dependence on this limited resource. Again reflecting their times, science museums began to address such issues in their programs and exhibits.

In the past 10 years, science museums have focused increasing attention on issues in science and technology. For many reasons, science museums are uniquely positioned to provide information about such issues to the general public. It would be difficult to overestimate the importance of this function. As Dr. Rustum Roy of Pennsylvania State University and the National Academy of Science notes, "Whatever we are doing in grade school, high school, and college, a very large fraction of the American population is simply not well equipped to deal with the realities of our technologically complex world. Hence...we must target our campaign at the average, non-scientist citizen."

What can science museums contribute to issues education for the general public?

- For one thing, *they have access to a large audience of "the average, non-scientist citizen."* Every year, tens of millions of people visit hundreds of American science museums—more than 55 million in 1993 alone. [1]
- *Science museums serve a broad cross-section of the population*; visitors typically include children from both inner-city and suburban schools, youth groups, teachers, young people on dates, prosperous families, and educated adults. Since people tend to visit science centers in small groups, a presentation in a science center offers the opportunity for a family or group to discuss and explore an issue together.
- Like other museums, *science museums are perceived as both neutral and authoritative.* Information obtained in a science museum is perceived as reliable, and the institution is not assumed to advocate a particular position.
- *Science museums are effective brokers,* providing the opportunity for various segments of the community to come together. Multiple perspectives illuminate the exploration of issues.
- *Science museums are not threatening.* There are no performance standards, no minimum competency is required, and no tests are administered. Science museums provide a safe, non-judgmental setting to explore complex, difficult, often divisive issues.
- *Science museums receive immediate feedback from their visitors.* This feedback includes both formal and informal response. Anecdotal information is derived through

direct visitor response. Difficult to analyze, such information is so powerful that it often is given disproportionate weight. Far more reliable is formal evaluation of science museum programs and exhibits. Through such studies, a body of data is beginning to emerge about issues education for the public. Although any conclusions are tentative at best, some factors seem relevant to issues programming in science museums.

➢ What Science Museums Have Learned: The Story So Far

• *Issues education presents unique challenges.* Complex information must be communicated, difficult topics explored. For a variety of reasons, including visitor expectations and attention span, the nonlinear nature of the museum experience, and the heterogeneous nature of the museum audience, this is not easy in the informal setting of a science museum.

• *Timing is crucial.* Interest in a topic can be ephemeral; the public is most responsive to a specific topic when it is in the news. Extremely rapid response is one strategy that can attract an audience.

• *Engagement is crucial.* Issues in science and technology often seem remote, "behind a glass wall," until they directly affect one's life. Several strategies can move the issue out from behind that wall, including theater—which uses emotion to bridge the gap between issue and visitor—and stories of real people.

The Science Museum of Minnesota documented visitor response to *Bionics and Transplants,* an exhibition on high-tech medicine. Although its subject matter is difficult and the treatment uncompromising, the majority of visitors found the exhibition both thought-provoking and entertaining. Exhibit components that focused on the experiences of actual individuals received particularly favorable response. Exhibit Developer Chris Burda concluded that the general public is most likely to respond favorably to issues that they feel are personally relevant to them, and that "reality provides this relevance."

• *Relevance is engaging.* A direct link to daily life or to a personal situation confers immediacy on the exploration of issues.

• *An issue is defined by time, place, and audience.* A particular topic may be an issue for one group, not another. Senior citizens tend to be interested in the politics of organ transplants; computer programmers, in electronic privacy issues. No one is more interested in environmental issues than the residents of a community being considered as the site of a waste disposal facility.

Serious consideration of the role of issues education in science museums raises profound questions. To explore these questions, an invitational conference was held in Washington, D.C., on January 22 and 23, 1994. Sponsored by the National Science Foundation (NSF), the conference was organized by the five partner museums of the Issues Laboratory Collaborative. This report is based on discussions during this event and was written by Ann Mintz, co-principal investigator of the Issues Laboratory Collaborative.

➢ Defining the Terms

"An issue is anything that makes the executive director nervous."

The words "issue" and "controversy" are often used interchangeably. Although both

words denote differences of opinion, they are not necessarily synonymous. All issues are not controversies and the existence of a controversy does not inevitably mean the presence of an issue.

A controversy can be defined as a question of fact. For instance, scientific *controversy* exists over what caused the extinction of dinosaurs at the end of the Cretaceous era. An *issue* raises a question that has alternative answers, and typically has normative implications. An issue raises questions of values: What *should* be done, and by whom? Should the results of genetic tests be available to anyone but the test subject? Should the developed nations of the world intervene to stop or slow the destruction of third-world rainforests? Controversies, on the other hand, surround whether something is true.

Thus, the existence of a controversy is straightforward, even uncontroversial. An issue can exist in the eye of the beholder, defined by time and place. Differences of opinion create the possibility of an issue. Relevance to a particular group creates the issue itself.

Issues arise in three categories.

- Some topics are issues in their own right. Examples include genetic engineering, the use of fetal tissue for therapeutic purposes or research, and land-use policy that seems to pit economic and environmental concerns against one another.
- An object can create an issue for a specific group when its use conflicts with the group's values. The display of ceremonial objects or human skeletal remains can be an issue for tribal groups. Items as diverse as a Confederate flag or images of the naked human body can evoke strong emotions—ones tied to the fundamental values of a community.
- An issue can be emphasized or even contrived by the juxtaposition of objects or concepts. *A More Perfect Union,* the Smithsonian Institution's exhibition on the internment of Japanese Americans during World War II, contrasts this chapter in American history with relevant sections of the Constitution. The conscious use of irony makes an issue of this historical period.

"Issue" and "controversy" are not mutually exclusive. Scientific controversy can be found within an issue. For instance, the existence of global warming is a scientific controversy about facts. Whether enough information is available to support action, and what that action should be, are value-laden issues.

Societal, ethical, and economic implications define an issue; emotion and values are almost always a factor; and complexity is a defining characteristic.

➢ Issues Education and the Nature of Science

By definition, *issues education includes two distinctly different kinds of information.* The first is scientific. Scientific information provides the framework needed to explore an issue. It can be presented with some degree of certainty. The second kind of information is more subjective, involving complex choices in the areas of politics, economics, and values. Because of the authority our society confers on science and scientists, it is not easy to make this crucial distinction. All statements made by scientists carry the aura of certainty, even if they are not scientific statements.

The public rarely understands that there is no single scientific point of view, that scientists do not always agree. This is a natural outgrowth of the way science is taught, as a body of knowledge rather than a dynamic process in which knowledge changes as new information is revealed.

➢ Issues Education and the Nature of Science Museums

For better or worse, public perception of science shapes the public perception of science museums. Although a halo of scientific authority surrounds science museums, the nature of that authority is not clearly defined. In recent years, discussion of the nature of science-museum authority has focused on questions pertaining to authorship, advocacy, and the presentation of issues for which no definitive answer exists.

Traditionally, museum programs and exhibitions are anonymous. They speak in a single, usually impersonal, voice. There is no equivalent to the signed editorial, the author's preface to the book. Multiple perspectives are presented by individuals from outside the museum. In general, the museum plays the role of the talk-show host, presenting various points of view without endorsing any. (However, without sufficient detail, it is difficult for the museum visitor to know the extent to which the museum is presenting the full range of points of view, or to ascertain which points of view are the most widely accepted.)

As a result of the use of an impersonal voice, the museum can be perceived as presenting absolute truth, not the reasoned conclusions of individuals. This is ironic, since most museum professionals recognize that there is no such thing as a neutral museum exhibit, and that every exhibition is the result of a host of decisions. Nevertheless, the public rarely deconstructs museum exhibitions. No canon has been established that reveals the multiplicity of decisions that are made as a program or exhibition is developed.

Uncertainty is a defining characteristic of issues. Issues involve difficult trade-offs, risk-benefit analyses that must incorporate imponderables such as values, and questions for which no clear answer exists. A significant amount of information is necessary to define such complicated issues; the sheer volume of information contributes to the challenge of developing programs and exhibits that explore complex issues in science and technology.

Issues are not static. New information is continually uncovered. Public perception shifts. An event such as the nuclear accident at Chernobyl or the explosion at Bhopal may intensify public concern for a time, and then fade from view as the public turns its attention elsewhere. Issues-related programs and exhibits may require frequent, costly, revision to stay current. This can present very real difficulties for science museums accustomed to working in longer time frames.

One of the fundamental questions facing science museums is that of advocacy, a question that is explored in more detail below. Should museums advocate specific positions? Or is it better to maintain a neutral position, presenting various positions but not endorsing any one? Should a museum be a forum for many opinions, or should it take a specific stand?

In general, the "forum" position is more widely accepted. However, advocating positions on certain issues may be accepted. For instance, many science museums endorse environmentalist positions and advocate recycling, rainforest protection, conservation, and efficient energy use. Imax films such as *Blue Planet* and *Tropical Rainforest* take strong environmental positions. Environmental issues now may be exempt from the general preference for neutrality.

Issues education exists at the intersection of science and society. In many ways, it

epitomizes the challenges of a fast-changing world. Science is part of a larger picture of change and uncertainty. Change induces anxiety; the human response frequently is to seek stability, constancy, and predictability. Successful issues education must engage people in the consideration of the issue at hand, provide a scientific framework within which the issue can be understood, and then empower people to make choices.

Serious consideration of issues education in science museums raises profound questions, with implications for exhibition and program design, marketing and audience development, external relations and fundraising. Despite these complexities, an unpublished study by Chris Burda of the Minnesota Children's Museum showed that many ASTC-member institutions have chosen to enter this arena, and have accepted the challenge of developing programs and exhibits that can help visitors better understand the choices that must be made in an increasingly technology-driven world.[2] Science centers are willing to take on difficult, complex issues.

➢ What Visitors Want

Any discussion of issues education in science museums inevitably leads to the museum visitor. There is considerable controversy in the field about visitor attitudes and opinions concerning issues programming. Do members of the public seek "The truth" at science museums? Do they expect clearly defined answers? Are they uncomfortable when scientists disagree with one another? Or will they accept open-ended exploration of the constellation of value questions that surround an issue? Are they willing to challenge their own beliefs, or do they want museums to validate them?

Given the diverse nature of the science museum audience, there is no clear answer to this question. Some studies suggest that visitors prefer definite answers. For example, Minda Borun, co-principal investigator of the Issues Laboratory Collaborative, carried out an unpublished study of a biotechnology exhibition at The Franklin Institute. The results suggested that visitors expected the science museum to raise issues, provide information, and then reach a conclusion. Visitors expressed discomfort with a presentation in which white-coated scientists expressed conflicting opinions about the potential dangers of genetic engineering. In this presentation, the differences of opinion were not questions of fact, but of interpretation and risk assessment. The scientists portrayed examined the same evidence and reached different conclusions. One group concluded that genetic engineering might present unanticipated problems, the other concluded that there is no evidence of problems strong enough to stop research with so much promise to solve serious human problems. This presentation was carefully designed to provide an unbiased exploration of this issue, in keeping with an often-expressed tenet that science museum issues programming should be strictly neutral. Visitor response was "If we can't believe scientists, who can we believe?"

• *Visitors are uncomfortable with scientific uncertainty; providing them a sense of the relative acceptance of various perspectives can help.* Beverly Serrell evaluated The Panda Game, an activity that challenged visitors to decide which of several animals were the panda's closest relatives. Visitors were not satisfied with an inconclusive answer. They accepted difference of opinion , but wanted to know what the majority of scientists believed.

• *Visitors want a body of information they can rely on as scientific fact.* They seem more comfortable when differing opinions relate not to facts, but to the potential

implications of scientific research or advances—and the value judgments associated with such issues—and when they are expressed by non-scientists.

• *Yet issues are not static, and public perception of issues programming may be changing.* Discussions at the Issues Laboratory Collaborative invitational conference inspired the ILC to carry out a study explicitly designed to investigate visitor opinions and preferences about issues programming in science museums. A report on this study can be found in the Appendix. Data from 450 adult visitors to The Franklin Institute, Discovery Place, and the Museum of Science (Boston) revealed that a large majority (84 percent) approved of museums' presenting different expert opinions; 89 percent wanted information about the impact of science and technology, not just the facts.

• *Visitors must be able to find themselves in any presentation.* Multiple perspectives can provide a mirror by which they see themselves and their point of view. Even if visitors

CASE STUDY: PASSIVE SMOKING

In 1992, the Science Museum, London, launched a series of seven small (50 square meters) exhibitions that concentrated on topics in contemporary science. In many ways, the Science Box series epitomizes many of the problems science museums confront when they embark on a program of issues education.

The Science Box series was aimed at non-specialists, particularly the family groups who comprise 75 percent of the museum's 1.3 million visitors each year. Each exhibition included text, artifacts, and hands-on interactives, and a striking modern design that immediately captured visitors' attention. Public events such as lectures, demonstrations, performances, and storytelling sessions complemented the exhibits.

Passive Smoking was the fourth in this series, inspired in part by discussion that surrounded the adoption of a no-smoking policy throughout the museum. When the museum's director suggested a Science Box exhibition on the health risks of smoking, the project team discovered that scientific attention at the time was focused on the hazards of second-hand smoke.

It soon became clear that the museum could not follow its usual policy of presenting a balanced, consensus view; no scientific consensus had yet emerged on the health risks of passive smoking. The Science Box team researched the topic, and concluded that passive smoking was detrimental to health. They decided to state openly in the exhibit that this was the team's position, not that of the museum. By openly taking a stand and offering reasons for it, the team hoped to head off complaints of pro-smoking lobbies that the museum was presenting a consensus view when in fact, consensus did not exist.

The exhibition itself presented a challenge to the designers. Much of the evidence for health problems created by passive smoking is epidemiological, based on the study of patterns of disease. This is a subtle statistical concept that is difficult to exhibit. The designers chose to present key ideas in the form of cartoons that simplified the topic without trivializing it. A table-top component, in the shape of the human body, was developed for children. Pull-up flaps over certain areas opened to reveal the parts of the body affected by second-hand smoke. Current press clippings were displayed throughout the exhibition's three-month run, though studies showed that they were of very little interest to visitors. More detailed information was offered by a computer interactive, and via a printed leaflet. (The museum printed 10,000 of these; they proved so popular that an additional 5,000 were produced.) A second computer station provided a feedback point, enabling visitors to register their views on passive smoking.

Like other Science Box exhibitions, *Passive*

seek certainty, they can be satisfied with the opportunity to compare their opinions to those of other people and confirm their own sense of understanding. They can then move beyond certainty, to new information and new understanding.

• *Ultimately, issues programming should empower science-museum visitors to have confidence in themselves and their own ability to understand a question to which no definitive answer exists.*

➢ Issues Exhibitions

Exhibitions are the heart of museums. They are what differentiate museums from other institutions. Since exhibitions are what museums do, science museums use them to

Smoking opened with a press event designed to capture media attention. Sir Richard Doll, who discovered the link between smoking and cancer, and Professor Nicholas Wald, an epidemiologist who has done important work on passive smoking, opened the exhibition with presentations on their work. Both the pro- and anti-smoking lobbies were invited, and the press kit included literature from both groups.

Two factors combined to ensure good attendance at this event. The pro-smoking lobby issued a press release with the provocative headline "Junk Science at the Science Museum." More important, the week before the opening, the U.S. Department of Health declared second-hand smoke to be a class one carcinogen.

Popular with the media and with the public, *Passive Smoking* inspired some dissent within the museum. The fact that the exhibition explicitly presented the opinion of the team rather than scientific consensus caused one senior curator to remark, "The museum should not have an opinion. That is not what we are here for."

"Quite disgraceful," another colleague wrote. "This must be the first time that the museum has maliciously condoned the victimization of 30 percent of the adult population."

Museum staff reached several conclusions during the two-year Science Box series:

• Specific, well-focused topics are easier to present than broader, more focused ones. DNA fingerprinting was easier to address than applications of lasers.

• Programs that complement exhibitions should not be targeted to a narrow audience segment. They should be broad enough to appeal to the general public, and are most successful when compatible with a family visit, or linked to a science curriculum and directly useful to schools.

• Printed leaflets are important. They allow staff to expand on the topic of an exhibition, and to target specific audiences.

• It is very difficult to develop an exhibition that responds rapidly to new developments in science. The Science Box team has found 12 weeks to be an absolute minimum.

In addition, the team continuously learned from experience gained as the Science Box series progressed. Over time, the average number of words per text panel was reduced to 50, the exhibitions were designed with open structures that create clear sight lines, and the most object-dense areas of the exhibitions were placed in the back, so that visitors could gradually come to terms with the content.

The Science Box series has proved successful. Two Science Box exhibitions (*Passive Smoking* and *SuperBike*) will be adapted for travel in the U.K., and the funder, Nuclear Electric, has agreed to sponsor a second series.

Staff at the Oregon Museum of Science and Industry (OMSI) encountered challenges when they developed their program component for the Issues Laboratory Collaborative. "Decisions, Decisions, Decisions" is a six-sided exhibit kiosk that explores the carbon tax, one strategy that has been proposed to control anthropogenic emissions of the greenhouse gas carbon dioxide. The kiosk was adapted from a similar installation that has proven successful in *Designer Genes*, an exhibition on biomedical ethics.

The "Decisions" kiosk is explicitly designed to present multiple points of view. Five of its six sides use text, graphics, and artifacts to present a specific point of view: scientific, economic, political, international, and environmental. The five points of view were selected by visitors, who chose among 20 candidate positions. The sixth side of the kiosk invites visitors to vote, registering their own opinions.

It proved difficult to mandate careful, sequential attention to the five points of view. Evaluation showed that some visitors voted first, attracted by the opportunity for interaction. However, those visitors who did use the kiosk as it was intended responded favorably to it, and evaluators documented significant cognitive gains.

explore issues. Issues exhibitions serve valuable functions. They provide much-needed information, involve visitors in the decisionmaking process, foster critical thinking skills, and underscore the real-world relevance of science and technology. An exhibition can foster interaction among visitors, empowering them to explore their own feelings on a complex topic. However, there are challenges inherent in developing science- and technology-related issues exhibitions. ILC conference participants readily identified some of these challenges.

• Interactive, hands-on exhibits are a defining characteristic of science museums, and many of the best interactive exhibits are phenomenon-based, communicating relatively concrete concepts. *But issues are not phenomenon-based, and they can be difficult to communicate with hands-on interactive exhibits.* Interactive exhibits can play a role in the exploration of issues. They can establish the scientific framework, illuminate basic science concepts, and explore risk assessment and probability. But deeper issues often are best elucidated with other media: computers, text, videos, cartoons.

• *Science museum exhibitions almost always are "random-access" media.* Visitors choose their own path; they can enter and leave at any point. Yet ideally, exploration of an issue should start with the facts. After the scientific context is established, the implications can be presented, and the various alternatives considered. This sequence is much easier to accomplish in a program than in an exhibition—another reason why programs should be considered an intrinsic part of an issues exhibition.

• *Few science museums can consistently provide an intensive staff presence in an exhibition.* There rarely is a facilitator to point out the preferred path through an exhibition, answer questions, and help visitors deal with emotional response.

• *Some subject matter is intrinsically difficult.* The National AIDS Exhibit Consortium's exhibition *What About AIDS?* addresses values-laden subjects such as sexuality and drug use. The Science Museum of Minnesota's *Bionics and Transplants* exhibition includes graphic images of medical procedures and burn patients. The Homer Museum's *Darkened Waters*, an exhibition on the environmental impact of the *Exxon Valdez* oil spill, contains distressing images of dead and dying animals and depicts the transparent pain of the human beings who loved the pristine environment of Prince William Sound. In an issues exhibition, fact and emotion are inextricably intertwined. The image of a dying sea otter may be difficult to confront, but it evokes emotion that builds a bridge between a museum visitor and an environmental disaster that may be thousands of miles away.

• *Issues are rarely simple.* It can be tempting to present complex issues in a binary mode: pro versus con. Even cursory analysis of most issues reveals a multiplicity of points of view, which must be simplified to communicate them to the public. Choosing which

points of view presents its own problems; a vocal constituency may represent a tiny percentage of the public. Economics and morality—areas where science museums traditionally have relatively little experience—raise the heat on the exploration of issues.

• *Illuminating complex issues in an exhibition requires a significant amount of text—written, in cartoons, on computer, or in videos.* Few visitors read every word in an exhibition; studies show that 50 words may be the optimum amount of text on a single panel.[3] Evaluation of the OMSI exhibit kiosk clearly showed that many visitors were not attracted by the text-heavy nature of the presentation. Science-museum staff reported concern about over-reliance on video presentations, especially when they are linear rather than interactive. Cartoons may be a promising strategy for providing text-based information in an attractive, nonthreatening way. Visitors also seem likelier to read text when it is displayed on a computer screen, especially when the display includes voting or other opportunities for interaction.

Science museum exhibitions provide an important medium for issues education. However, conference participants indicated that programs enhance issues-themed exhibitions, and advised against isolating modalities when addressing complex issues.

➢ Issues Programs: The Human Dimension

Programs are a crucial component of museum-based issues education. The combination of programs and exhibitions broadens and deepens the educational experience. Together, programs and exhibitions are synergistic: The whole exceeds the sum of the parts.

Programs provide several concrete advantages for the exploration of issues in the museum setting.

• *Programs can be sequential.* They have

A theatrical presentation called *The Long Cold Summer* is a key component of *Greenhouse Earth*, an exhibition on global climate change developed by the Association of Science-Technology Centers and The Franklin Institute. *The Long Cold Summer* is a portrait of a New England farm woman during 1816, the "year without a summer." This 20-minute, one-act play shows what a few degrees of difference in average temperatures means in the real world—snow in July, failed crops, and a family losing its farm. It dramatizes the abstract scientific concept of average temperature, and helps museum visitors understand why global climate change may be a significant issue.

Another theatrical presentation was developed by the Orlando Science Center as part of the Issues Laboratory Collaborative. *Mango and Me* is designed for younger children. It tells the story of Little Jo's visit to the beach with Mango, a stuffed toy that comes to life and explains global climate change to his young friend. *Mango and Me* has been used during several venues of *Greenhouse Earth* to supplement *The Long Cold Summer*, helping younger visitors grasp this complex subject.

Discovery Place in Charlotte, N.C., developed a cart-based demonstration on the science of global climate change. The discovery cart demonstration included hands-on interactives and charts that supported the presentation. Evaluation carried out by the ILC showed that the enthusiasm of the presenter was a key variable. Post-presentation questionnaires showed that audiences learned more from enthusiastic staff, in part, perhaps, because enthusiastic presenters tended to tailor their demonstrations based on audience response.

The discovery cart was replicated for each partner museum in the ILC and evaluated in each location. Several unanticipated results surfaced during this process. All five partner museums employ cart-based demonstrations. However, each defines "cart-based demonstration" differently. Each institution has its own programmatic style to which both visitors and staff are accustomed. Variables included program length, the complexity of the information presented, and the amount of audience interaction. Another key variation can be characterized as "linear" versus "random access." In some ILC institutions, audiences often attend an entire program or demonstration. In others, people are accustomed to joining an audience while the program is in progress, or leaving before it is completed. In addition, staff proved to be somewhat resistant to presenting programs that had been developed elsewhere. As a result, the discovery cart proved most effective when each partner museum could use it flexibly to support its own program style.

a beginning, a middle, and an end. A program can establish a scientific framework, then present various points of view, suggest alternatives, and explore the implications of each.

• *Programs are flexible.* Exhibitions are an expensive medium, difficult to alter rapidly. A skilled presenter can tailor a program to the audience, simplify it when he or she senses the need, and include current information to underscore its relevance. Programs also can be developed specifically for a target audience, such as adults, younger children, or teachers.

• *Programs can be interactive.* A presenter can invite audience response, answer questions, provide further information, offer the opportunity for dialog. This verbal exchange can help develop critical thinking skills, and encourage visitors to discuss an issue with one another.

The more emotionally loaded an issue, the more important it becomes to provide this opportunity for interaction. This emerged clearly in the development of *What About AIDS?*; evaluator John Falk noted that visitors embraced the opportunity to discuss this exhibition and work through their feelings about a difficult topic.

• *Programs, especially science theater programs, provide a powerful medium to explore the ethical and emotional ramifications of issues.* They represent the human side of issues. Museums, such as the Museum of Science in Boston, are moving towards an integrated programmatic strategy. Basic science is presented by interpreters and demonstrators within exhibitions. More complex, emotional, issues are addressed via science theater, usually in formal theater settings. Theater also can add a humorous touch to the

CASE STUDY: GLOBAL GAMBLE

The Franklin Institute produced "Global Gamble" under the auspices of the Issues Laboratory Collaborative. This presentation was designed for use in the video wall-based Musser Choices Forum. Using a game show format, "Global Gamble" presents basic scientific information about global climate change, then invites visitors to select among alternative strategies to slow down the process.

Formative evaluation played a major role in shaping program development, affecting everything from the sequence of the presentation to the number of alternative scenarios that were explored. As formative evaluation proceeded, the number of respondents who could correctly explain global climate change rose from 27 to 58 percent. The number of visitors who could name at least one greenhouse gas grew from 35 to 78 percent.

Visitors made the most dramatic cognitive gain in their ability to distinguish between ozone depletion and global warming. In initial testing, only 16 percent of the sample understood that there is no causal relationship between these two phenomena. An early version of the program addressed this head-on by stating simply that the hole in the ozone does not cause global warming. Ironically, the number of visitors who associated the two actually increased. Apparently the juxtaposition of the two concepts was more powerful than the negative statement in which they were included.

A later version emphasized the scientific distinction between the ultraviolet radiation admitted by the ozone hole and the infrared that is trapped by greenhouse gases. This strategy proved far more effective; summative evaluation showed that 72 percent of the sample understood the distinction between global climate change and ozone depletion.

Formative and summative studies also revealed areas where minimal change occurred. Participants in both studies felt that

exploration of complex, difficult issues. It can serve almost as a live comic strip, providing catharsis for emotions evoked in more serious presentations.

The human dimension makes programs important to museum-based issues education. It also creates challenges. Evaluation of the ILC project found that program staff are not always comfortable presenting complex issues. They may prefer clear-cut basic science presentations to questions that lack unequivocal answers. Staff at some ILC partner museums expressed discomfort with the topic of global climate change, preferring clear information backed by strong scientific consensus to a body of data that is not yet fully understood.

Programs clearly play an important role in museum-based issues education. The interaction between programs and exhibits merits formal investigation. Ideally, they should be evaluated both separately and together to determine their cumulative impact.

➢ Evaluation

Evaluation is crucial to developing educationally effective programs and exhibitions. Professional knowledge and intuition must face the reality check provided by formal studies with museum visitors. As Alan Friedman, director of the New York Hall of Science, pointed out, it is "not the cheapest way to develop exhibits. But it is the cheapest way to develop effective exhibits."[4]

Front-end evaluation is always important, but especially so with issues-related

global climate change was a serious problem that would be important to them in choosing a candidate for office. The baseline levels were so high that no significant change was documented. In general, ILC studies found strong but uninformed concern about environmental issues, and general acceptance that global climate change is indeed a problem.

This illustrates an unanticipated conclusion reached by the ILC partner museums. *Public perception of an issue can differ from the perception of experts.* Significant controversy (difference of opinion about facts) may exist in the scientific community. This controversy leads to an issue—difference of opinion about what action, if any, is appropriate. Comparable controversy does not seem to exist among the general public, who seem to be convinced that a problem exists and that action must be taken.

Published studies also show that relatively brief exposure to educational programs can have a significant impact on public opinion. For example, the Public Agenda Foundation compared the opinions on global climate change of 402 members of the general public with those of 418 scientists.

Citizens participating in the study were tested before and after watching an educational videotape that outlined the issue, the nature of expert disagreement about the seriousness of the problem, and the pros and cons of various solutions. According to John Doble, research director for the foundation, "We were astonished at the degree to which public opinion moved closer to that of trained scientists after only an hour of education."

Overall, scientists and citizens agreed on many proposals to address the threat of global warming, such as spending more on solar energy and mass transit, increasing miles-per-gallon standards to 50 by the year 2000, and requiring utilities to burn less coal, reducing the number of trees cut, and providing tax breaks for improved insulation for builders and homeowners.

programs and exhibitions. If visitors do not understand the science behind the issue, they cannot possibly understand the issue itself. Only front-end evaluation can reveal the state of visitor knowledge on a specific topic. ILC front-end studies, for instance, confirmed what the work of cognitive anthropologists such as Willet Kempton of the Princeton University for Energy and Environmental Studies has shown regarding public understanding of climate change.[5]

The ILC evaluation found that as many as 90 percent of respondents believed that ozone depletion causes global climate change. This is a perfect example of an internally consistent but incorrect cognitive model. The concept is simple, almost elegant: sunlight enters the atmosphere through a hole in the ozone. Trapped by greenhouse gas, it cannot escape, so global temperature rises. Although the genesis of this misconception was not investigated, ILC evaluator Minda Borun suggests that the confusion may arise from a tendency for visitors to not differentiate among environmental problems. Further, the chlorofluorocarbons that have been implicated in ozone depletion also are powerful greenhouse gases. One result of the misconception is that many visitors thought that global warming could be ameliorated by eliminating the use of aerosol containers, apparently ignorant that CFCs no longer are used as aerosol propellants in the United States.

Front-end studies conducted by John Falk for the National Museum of Natural History in Washington, D.C., revealed comparable information about visitor understanding of environmental issues: strong concern coupled with lack of information. Although the vast majority of the participants could not define "ecosystem," they knew that environmental problems existed. The exhibition could focus on providing information, not persuading visitors that problems existed.

One of the original goals of the ILC was to determine the relative effectiveness of the five program formats employed by the partner museums. This was why two formats—the OMSI "Decisions" kiosk and the Discovery Cart demonstration—were shown and evaluated in each museum. For the reasons described below, relative effectiveness could not be determined.

Evaluation of the OMSI exhibit kiosk clearly revealed several external factors that affected evaluation data. The context and location of the exhibit had a profound impact on its reception by visitors. During its formative evaluation at OMSI, the kiosk was a prominent feature of an exhibit hall. In Charlotte, it was displayed next to a dramatic rain forest exhibit, adjacent to several aquariums. In Philadelphia, it was near the famous "giant heart," one of the science museum's enduring icon exhibits. The kiosk simply could not compete with such compelling exhibitions. A different set of variables affected results at the Orlando Science Center. OSC tends to draw a younger audience than most science museums. The sophisticated information presented by the kiosk did not attract this young audience, and a valid sample could not be obtained.

In sum, there were too many uncontrolled variables to make valid comparisons, and it proved impossible to decouple factors relating to the topic from those relating to the program format and the venue in which it was presented.

The ILC experience unequivocally documents the importance of evaluation. Dramatic cognitive and affective gains were recorded as the iterative process of formative evaluation, program revision, and reevaluation proceeded. (See Case Study, pp. 12-13.)

Formal visitor studies are crucial to developing effective programs and exhibitions; they are especially important to issues-related presentations. Although the vast majority of studies have focused on specific projects, it is possible to suggest some more general conclusions. Highly tentative, they should be tested by further studies.

• *Issues presentations sometimes endorse preferred behaviors.* Presentations on such topics as AIDS and smoking specifically endorse preferred behavior. However, studies of the impact of such efforts confirm what decades of social-psychology research show: that providing information does not necessarily change behavior. Information can provide a rational justification for a decision

that has been made for other reasons. In and of itself, it is unlikely to change attitudes or behavior. Peer pressure can be far more powerful than scientific information. For example, studies carried out by the California Department of Public Health suggest that telling teenagers that the smell of tobacco smoke is unappealing to the opposite sex is more effective than warning them of cancer risks in what seems to them the distant future.

• *Behavioral changes take place incrementally over long periods of time.* The data on seat-belt use and drunken driving are unequivocal, but only recently have they resulted in significant behavioral change. The Centers for Disease Control and Prevention documents a sharp drop in alcohol-related traffic deaths between 1982 and 1993.

• *Multiple points of view are important for a variety of reasons. Not only do they allow visitors to "find themselves" in an exhibition and personalize sometimes-abstract topics, they provide a variety of entry points to an issue.* Focusing on a single point of view might seem exclusionary.

• *If visitors think that a causal relationship exists between two factors, a simple negative will not change their minds.* Visitors apparently do not see the word *not,* as clearly shown by the ILC evaluation of the Franklin Institute's "Global Gamble." This conclusion was confirmed by Alan Hedge, professor of human factors engineering at Cornell University. At a 1994 conference sponsored by Science Learning, Inc., Hedge noted that the first law of human factors engineering is "Always state information in positive terms."[6]

• *First-person voice is a powerful entry point to the exploration of issues.* As Chris Burda found in her evaluation of *Bionics and Transplants*, stories of real people can be very compelling to visitors. Regarding the campaign to increase use of seat belts, "we tried for years," said the National Highway Traffic Safety Administration, "but nobody listened until they saw the faces" behind the statistics.

• *Public interest in a topic may be the best predictor of the success of an issues-related exhibit.* John Falk and Beverly Serrell both noted that if people think that they need to know about a topic, they will find it more interesting, and will seek out information about it even if the topic is difficult or challenging.

• *Many programs and exhibitions must be evaluated in many venues before reliable information can be obtained about the relative effectiveness of specific program formats—or even to settle on common definitions and measures of "effectiveness."*

➢ External Relations: The World Outside the Walls

Museum-based issues education is unquestionably complex. Several factors contributing to this complexity relate to the impact of the presentation—actual, potential, and perceived—on constituencies outside the museum. The opinions and reactions of visitors, scientists, donors, and trustees must be considered.

Visitor response to issues programming has been discussed throughout this report. Other visitor-related questions concern both mission and marketing.

Many science museums include positive affective goals in their mission statements. They seek to promote science, entice people into scientific pursuits, spark curiosity, excite interest, show that science is fun. Often, these affective goals are quite explicit, as expressed in slogans such as "Feel the Fun" or "Where Science is Fun." In general,

although issues can inspire an emotional response, they are not fun. They can be difficult and painful, raising serious questions about the role of science in society. The recent controversy over the Smithsonian Institution's exhibition *Science in American Life* raises such questions. Commentators and reviewers in such publications as *Science* and *The Washington Post* expressed conflicting views of the exhibition. Some found it anti-science, presenting a negative view of the impact of science on American life. Others felt it was a fair presentation of the relationships between science and society.

It is far easier to define the questions than to propose answers. Should science museums always promote positive attitudes towards science? Can they participate in meaningful debate about science and society? Must science museums always be fun?

Other questions relate to marketing. Science museums rely increasingly on earned income. Visitor appeal is a key criterion when decisions are made concerning programs and exhibits; many visitors are drawn by the intersection of education and entertainment they find in science museums. *To most people, even the educated families that form the majority of science museum visitors, issues are not entertaining.*

But issues are important, and are often perceived as such by visitors. People do not attend an AIDS exhibit because they think it will be fun. They attend because they know it is important, and they need the information. Nevertheless, an exhibition on super heroes or movie special effects is likely to draw more crowds than an exhibit on AIDS, acid rain, or species extinction—unless, it seems, dinosaurs are the species in question.

A different dynamic applies to school visitors to science museums. Staff of the ILC partner museums report that issues exhibitions can provide a valuable resource for educators who may be attracted to the timeliness of the topic, the opportunity to foster discussion and critical thinking, and the all-important link to the real world.

Scientists are another constituency that must be considered. Scientific accuracy is of paramount importance to science museums, and scientific advisors are key members of most project teams. Indeed, each of the ILC institutions drew on the advice of a wide array of advisors. This advisory process can become complicated when an issue involves scientific controversy, i.e., difference of opinion concerning questions of fact, questions for which there are no clear answers, and complex risk-benefit analyses. Scientists are far more comfortable than is the general public with incomplete data, but can be reluctant to go "on the record" before definitive information exists.

Conference participants reported that it can be difficult to reconcile scientists' concern for absolute accuracy with the public's need for reliable but accessible information. Scientists also have a much higher tolerance for information overload than the general public does. The challenge is finding a way to present complex information in accordance with Albert Einstein's sage advice: "Everything should be as simple as possible, but no simpler."

Donors are another inevitable concern for science museum management. The concern falls into two categories: availability of funds, and involvement of donors in content decisions. Some donors are comfortable with the concept of issues programming in science museums and willing to support it. The Science Museum, London, reports an excellent relationship with Nuclear Electric, the principal funder for the Science Box series. Complete control of content has remained with the museum. According to Graham Farmelo, Nuclear Electric is so pleased with the project that it has agreed to fund a second series as well as traveling versions of two of the Science Box exhibits. John Shane, vice president for programs at The Museum of Science, Boston, reports consistent success in raising funds for its issues-oriented science theater presentations, which address topics as potentially explosive as fetal tissue research. On the other hand, the National AIDS Exhibit Consortium initially experienced significant difficulties raising funds for the AIDS exhibition. *Experience*

suggests that is easier to obtain support for a blockbuster exhibition that is sure to be popular with the general public than for an exhibition on a more difficult topic.

Donor involvement in content decisions is an extremely touchy subject. Many museums report that donors leave content decisions in the museum's hands. However, unsubstantiated but prevalent rumors suggest that some funders have insisted on editorial control of exhibitions, *issues-related or not.* Without attribution, it is impossible to know whether this reflects anxiety or actuality.

Different dynamics apply to individual donors, foundations, and corporations. For obvious reasons, corporations are more likely to be sensitive to issues-related topics, especially those that concern their own industries. A key factor here is the maturity of the corporation itself. Joel Bloom, founding president of ASTC and president emeritus of The Franklin Institute, points out that organizations, like individuals, have life cycles, and that older corporations often have sophisticated definitions of corporate citizenship. They understand that responsible coverage of issues benefits them. Newer corporations may lack this sophisticated understanding, and thus be less open to supporting issues-related programs and exhibits.

Museum trustees are key stakeholders. They serve as bridges between the museum and its community, and they often represent important external constituencies. As the governing body of the institution, they may sign the director's paycheck. *It would be foolhardy for a museum to address controversial topics without ensuring the trustees' support.*

Education is a first step in obtaining this support. Some museums have invited subject experts to present information to the board. An AIDS caseworker may be far more effective than a staff member in explaining the importance of AIDS prevention. John Shane, a member of the National AIDS Exhibit Consortium, conducted a front-end study of the attitudes of his institution's own Board of Trustees, and learned that the Board was far more willing to take risks than the staff had anticipated.

Sometimes, an issues-related program or exhibit inspires intense, even unprecedented, trustee involvement. For instance, the Board Education Committee of another member of the National AIDS Exhibit Consortium asked to review the text for the AIDS exhibition, criticized what was perceived as insufficient emphasis on abstinence as a prevention strategy, and expressed concern about potential objections of parents whose children would be exposed to the often-frank information presented in the exhibition. Staff met intensively with this subcommittee, responded to their concerns, and reached consensus concerning the approach the museum should take. The committee was then able to help support the staff position with the rest of the Board.

Visitor studies can play an important role in trustee relations Visitors may be less

Original plans for the ILC included staff training, intended to help program staff respond appropriately to strong visitor response to programs on global climate change. As the project developed, the anticipated visitor response never took place. There may be scientific controversy associated with global climate change, but to museum visitors, it literally was not an issue.

Ironically, the most emotional visitor response was from a visitor who was outraged by the contention that ozone depletion was not directly linked to global climate change. This common misconception was identified during front-end studies. Correcting it was one of the cognitive goals for several ILC presentations. This particular visitor insisted that ozone depletion—the "hole in the ozone"—caused global warming.

In retrospect, it might have proved more valuable to implement a different kind of staff training, one that included science content, program philosophy, and techniques that provoke thoughtful visitor response. In-depth discussion of issues education took place at higher levels within each organization. Better orientation for the front-line staff who interact daily with visitors might have deepened their understanding of the role of issues education within science museums.

sensitive than trustees fear. *Trustee concerns can be alleviated by reliable information about visitor attitudes, opinions, and beliefs*

Several science museums have developed guidelines for working with trustees. Roree Iris-Williams, then-vice president for education at the Franklin Institute Science Museum, put together a set of concrete suggestions for increasing trustee comfort level:

1. Communication is critical. Staff must listen to and hear trustee concerns.
2. Everything will take longer than anticipated. Several meetings, discussions, presentations, and project overviews will be needed before all concerned reach an acceptable level of comfort.
3. Identify allies, advocates, and obstacles early in the process. Look for support, and call upon it.
4. Assemble an advisory team of trustees or use an existing committee or subcommittee. Ideally, one trustee will emerge as a spokesperson who can mediate between the staff and the full board.
5. Be open, honest, and forthright. Don't promise anything you can't deliver.
6. Be knowledgable. Provide information and/or access to experts.
7. Be patient, understanding, and sensitive to multiple points of view.
8. Do your homework. Include key stakeholders: schools, churches, community groups.
9. Try to anticipate concerns, sensitivities, and questions.

The Oregon Museum of Science and Industry developed a "Briefing Paper for Trustees on Scientific and Technological Innovations that Create Social and Ethical Issues." Written by OMSI President Marilynne Eichinger, it established a context within which to explore decisions concerning such issues. This document defined the assets and liabilities inherent in taking a proactive stand. Premises included the following:

1. It is not OMSI's role to take a position but rather to illuminate the various sides of a debate and to present science as we know it.
2. An advisory committee should be formed for each issue that we choose to consider.
3. Board as well as staff should be informed about a program or exhibition before it opens. They should be given the tools for answering questions if they arise.
4. Staff should use tact in presentations. The goal is not sensationalism, but information.

Assumptions (which OMSI described as assets) defined in the paper included:

1. We are in an era where scientific and technical change often run ahead of our laws.
2. OMSI's staff is sensitive to the need to discuss issues without offending people.
3. Many people do not have the tools for decisionmaking.... They find themselves called upon to ... make decisions that are often based on a lack of knowledge. Our future may be determined by sensationalism, fear, and bias that have no grounding in fact.
4. By making science relevant so that people start to understand why science is important, they may be drawn into learning more.
5. Briefing papers and other communications efforts can engage trustees in the decisionmaking process and ensure that they understand the rationale for taking on a potentially controversial topic.

No matter how carefully a science museum proceeds, conflict always is a possibility, and some issues cannot be easily resolved. Issues relating to sexuality, race, and gender can be

especially difficult. Yet a workable approach can be developed for most topics.

The most difficult obstacles for museums to surmount may be internal, not external. Self-censorship may be more powerful than censorship from outside. It may literally be true, as one conference participant noted, that we have nothing to fear but fear itself.

➢ Advocacy: The Issue of Issues

One of the most controversial aspects of issues programming is the question of advocacy. Should museums advocate particular positions? Or should they remain unbiased, carefully presenting multiple points of view concerning each issue? In theory, the latter position is far more prevalent. In practice, advocacy is a continuum, not a dichotomy. Museums endorse environmental positions such as energy efficiency, habitat protection, and appropriate and sustainable technology, and zoos and aquariums routinely endorse positions on species extinction and marine conservation. As the AIDS epidemic continues, museums advocate behavioral changes to slow the spread of the disease. Museums also advocate preferred behaviors concerning substance abuse, smoking, nutrition, and exercise.

These are easy positions to advocate. Joel Bloom observes that it is not advocacy to take a position that everyone shares. *Although questions of advocacy become more complicated when issues arise about which rational, well-meaning people disagree, Bloom believes that museums must be willing to take strong advocacy stands.*

The debate on advocacy is relatively new. As recently as 20 years ago, many science museums routinely presented exhibitions that uncritically endorsed positions espoused by the funders. Some even accepted exhibitions designed by funders. In this context, it is clear that the widespread agreement that science museums should be unbiased in their presentation of issues reflects increasing organizational maturity. Bloom notes that the story of issues education in science museums began with uncritical acceptance of positions espoused by donors. The next step was careful avoidance of any controversy; then came the current emphasis on balance and lack of bias. *The debate on the next step has just begun.*

The press provides a useful model for the differentiation of factual reporting and personal opinion. Here, the canon already has been established. A news story is balanced; an editorial or a column can advocate a particular position. The press may be accused of covert bias in its coverage of a particular issue, but there are few objections to presentations of opinions that are clearly defined as such.

No such model exists in museums. Design strategies can present the opinions of various constituencies: scientists, environmentalists, politicians, etc. *No foolproof design strategy has been developed to attribute museum exhibitions to their authors.* When attribution is attempted, it is not understood by visitors. For instance, *What About AIDS?* includes a panel with photos of the exhibit developers, and text conveying their accounts of why they undertook the exhibition project. Yet, if visitors notice it at all, they assume that the photos depict scientists, or people with AIDS—perhaps because of the large number of photos of people with AIDS scattered throughout the exhibition.

The questions are easy to define: Should museums advocate positions? What positions—if any—does the public expect science museums to advocate? Can there be too many advocates, too many people and institutions willing to take stands? Is museum credibility grounded in neutrality? Will advocacy erode this credibility? What is the

proper balance between objectivity and advocacy? The answers to such questions remain elusive, but exploration of the "issues of issues" will surely continue.

➢ Conclusion

In science museums as in science, the truth may be ephemeral. The process of seeking truth is not. ILC conference participants agreed that serious discussion of the role of issues education raises many of the most important questions facing science museums. The debate is unlikely to end; it will evolve as this dynamic community of informal educational institutions refines its definition of its role in our society.

FOOTNOTES

1. The figure comes from the *ASTC/CIMUSET Directory & Statistics.* Washington, D.C.: Association of Science-Technology Centers, 1994. It is based on self-report of attendance among 186 U.S. science centers, botanical gardens, aquariums and zoos, and natural history and children's museums that comprise ASTC's museum membership.

2. Burda, Chris. "Exhibition Communication and Design of Controversial Issues in Science Museums," master's dissertation, John F. Kennedy University Center for Museum Studies, 1990.

3. A study by Paulette McManus, a museum consultant, indicates that "visitors can be reading exhibit labels when it looks as if they are not." She reached this conclusion from a study of 114 recorded visitor-group conversations and observations, in which she found that conversations even among groups coded as not having read the labels contained verbatim segments or paraphrases of label copy. McManus argues that visitors interpret and share labels in a conversational context, and labels should be written with that in mind. Nonetheless, she cautions that "it is unlikely that an entire label text will be attended to, no matter how long or short it is." The study appears in *What Research Says About Learning in Science Museums, Volume 1.* Washington, D.C.: Association of Science-Technology Centers, 1990.

4. Friedman, Alan. "Convincing the Director," paper presented at the Visitor Studies Conference, London, 1993; appears in Bricknell, Sandra, and Farmelo, Graham, eds., *Museum Visitor Studies in the 90s.* London: Science Museum of London, 1993, pp. 43-46.

5. Kempton, Willet. "Lay Perspectives on Global Climate Change," Princeton University/Center for Energy and Environmental Studies, Report 251, August 1990.

6. The proceedings of this conference appear in Falk, John, and Dierking, Lynn, eds., *Public Institutions for Personal Learning: Understanding the Long-term Impact of Museums,* Washington, D.C.: American Association of Museums, 1994.