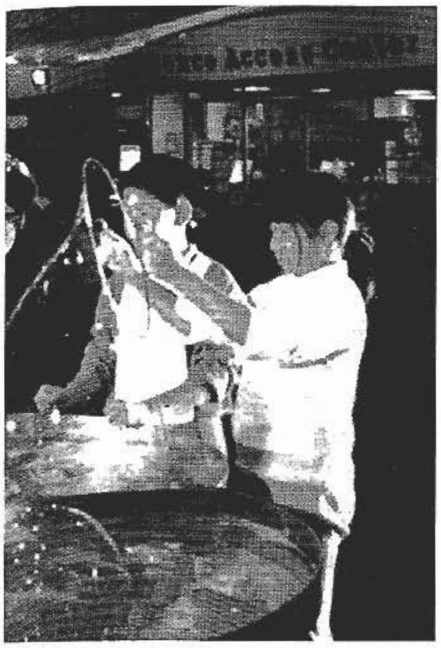


Museums, Communities, and Contemporary Science

Alan J. Friedman

Science museums are a billion-dollar-a-year industry, supported by a mixture of communities: government, corporate, individual, and foundation, as well as the general public. Science and technology centers are a relatively recent subset of the science museum realm, with a specialization on "hands-on" or "interactive" exhibits, and a spectacular record of growth. In 1972 there were 17 institutions that identified themselves as belonging to this category. Today there are 450 such science-technology centers in the world, most of them created within the past 20 years. In the United States alone they draw over 100 million visitors a year.[1]

Along with the generally happy situation, however, there have been some serious questions about the roles and effectiveness of science museums and science centers, and a few disturbing near-failures. A dozen science museums have found themselves in life-threatening situations, most often but not always beginning with overruns in the costs of initial construction or of a capital expansion. These examples of serious problems, facing such well-established museums as the Franklin Institute, the Oregon Museum of Science and Industry, the Smithsonian, and highly promising newcomers like the Columbus Center, Liberty Science Center, and newMetropolis, suggest that it is important not to take community support for science centers and museums for granted. Indeed, some unexpected event, like a cost overrun or a controversial exhibition, may cause the various communities of stakeholders to discover suddenly that they each have wanted different things from these institutions.

This paper discusses four major communities that are critical to science museums, and offers views of where the interests of these communities coincide and where they differ. These four constituencies are scientists, public visitors, funders, and museum staff. This analysis is based primarily on the author's experiences at his own institution and at other U.S. science centers and science museums. The term "science museum" is used here to refer to all types of science-technology museums and centers.

WHAT SCIENTISTS WANT A SCIENCE MUSEUM TO DO

Scientists and scholars want to educate the public about the fundamentals of their fields. They want museums to explain the processes through which science creates and learns. They want to celebrate the achievements, both historical and contemporary, of which they are most proud.

Scientists and curators also want contemporary science content. The major events of 20th-century science, including relativity, quantum theory, DNA, and the expanding universe, are among the topics that scientists believe should be covered.

WHAT VISITORS WANT A SCIENCE MUSEUM TO DO

The public that visits museums is not, in general, looking to learn any specific information. Family visitors say they want a pleasant, entertaining afternoon together. Individual communities want to see celebrations of science and technology related to their own culture and history. There is one overriding demand: to explain how the subject directly relates to the visitor's own life, and what the visitor already knows and is interested in.

When the New York Hall of Science did extensive "front end" evaluation for an exhibition on microbial life, and another on chemistry, we learned that visitors were almost exclusively interested in those microbes that they had heard about in the mass media recently, such as the viruses which caused AIDS, or which had affected them directly, such as the common cold. Visitors were also interested in the chemistry of their own bodies. They did not volunteer a strong desire to learn about the underlying principles, the classifications and terminology, or the processes of investigation that scientists used to learn about microbes.

WHAT FUNDERS WANT A SCIENCE MUSEUM TO DO

In general, funders want to be associated with excellence and success. An institution with strong visitorship, an excellent public reputation, and a healthy financial situation is likely to attract government, business, and individual support. The funders want their own judgment in recognizing excellence, and their generosity, to be recognized and celebrated as well.

Beyond these general attributes, however, funders are also looking for institutions to contribute to the quality of life of their communities in several specific ways. The government of New York City, for example, is most impressed by the role museums play in stimulating the City's economy. The Cultural Institutions Group of New York City, which represents 34 museums receiving the most funding from the City, estimates that the US$ 84 million that City government spends on these museums plays a key role in generating US$ 2,000 million in economic activity. This activity includes the direct and indirect impact of spending by the institutions themselves, and increased tourism.

Quality cultural institutions also contribute to the residents' sense of well-being in their neighborhoods, making people happier to live in a particular region. This argument is appreciated by corporations that want to attract and retain employees, and it is appreciated by businesses such as real estate investors.

WHAT STAFF WANT A SCIENCE MUSEUM TO DO

The museum exhibits and education staff of science museums are acutely if quietly aware of the limitations of the exhibition medium. First, many exhibit developers hold that what counts is not what was *intended* by a design, or even what an exhibition *presents*, but only *what the visitor actually takes away from the experience.* Science-technology museum visits typically last one to three hours; individual exhibit units typically hold visitors for between 30 seconds and 3 minutes. Within these constraints, exhibits can make limited (if lasting) impacts on visitors' knowledge and attitudes.[2]

Exhibits can be expected to communicate only simple stories. "Hands-on" exhibits are best at presenting the sensory impact of real objects and phenomena. You can see, hear, and smell the spark from a Van de Graff generator; feel the effect of a compound pulley; watch in real time the unpredictable life and death of individual microbes. Simply putting a phenomenon or object on display celebrates it, but usually fails to be effective in placing a phenomenon in a broader or deeper context. Exhibitions that try to do too much may only confuse or intimidate most visitors, who enter a science museum somewhat timidly anyway.

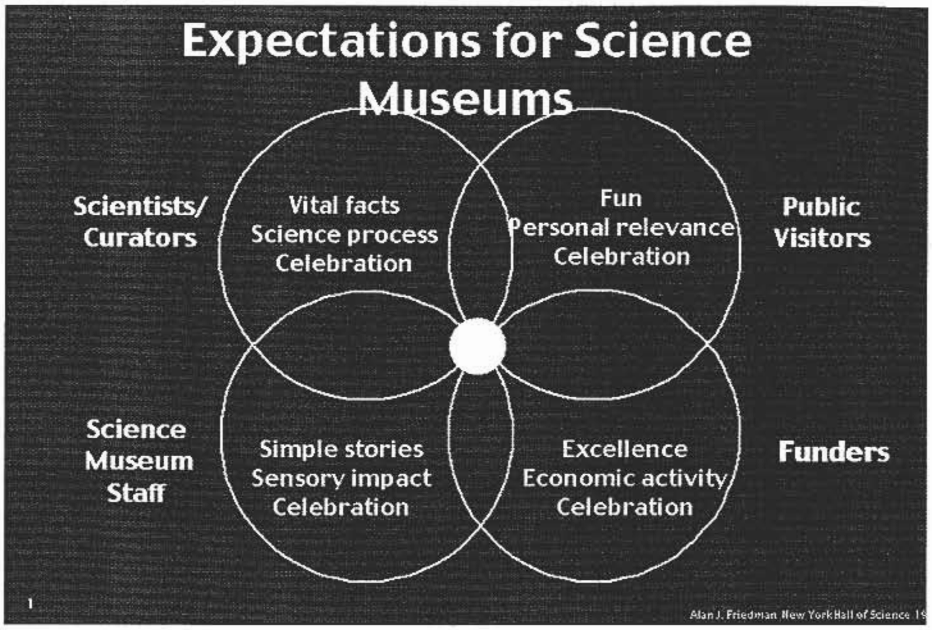


CHART 1.

WHERE THE EXPECTATIONS OF THESE FOUR COMMUNITIES OVERLAP

These four sets of expectations overlap primarily in the word "celebrate" (**Chart 1**). When they find the right things to celebrate, science museums have a chance of pleasing everybody a little bit, even if they reach only a small part of the full potential each of the stakeholders wants to achieve. Most science museum exhibits today are, indeed, celebrations of some object or phenomenon. Celebratory exhibits normally present little controversy, but these exhibits also usually present little contemporary science, little opportunity to understand the processes of science, little of the broader context that may be required to make the subject of an exhibit truly important.

COMPONENTS OF EXHIBITIONS THAT PLEASE EVERYONE

Gyroscope (Figure 1, at Techniquest in Wales): The bicycle wheel gyroscope celebrates a very

FIGURE 1. Bike Gyro exhibit at Techniquest, Wales.
Photo: Alan J. Friedman

fundamental phenomenon, and because it behaves in an unexpected manner, the device also delights visitors. Industrial applications of the gyroscope are part of several major achievements in contemporary technology.

Soap Bubbles (Figure 2, at the New York Hall of Science): Making giant bubbles illustrates several important phenomena, although few visitors know the language scientists use to describe those phenomena. Nevertheless, the popularity of bubble phenomena is strong among the public because the sense of accomplishment, esthetics, and connections to everyday experiences make the bubbles accessible to everyone.

Catenary Arch (Figure 3, at the Exploratorium in San Francisco): Like the gyroscope, arch bridge exhibits, both large and small, demonstrate something important in science and mathematics,

FIGURE 2. Soap Bubbles exhibit at the New York Hall of Science, part of the *Seeing the Light* exhibition created by the Exploratorium, San Francisco.
Photo: Ken Howard

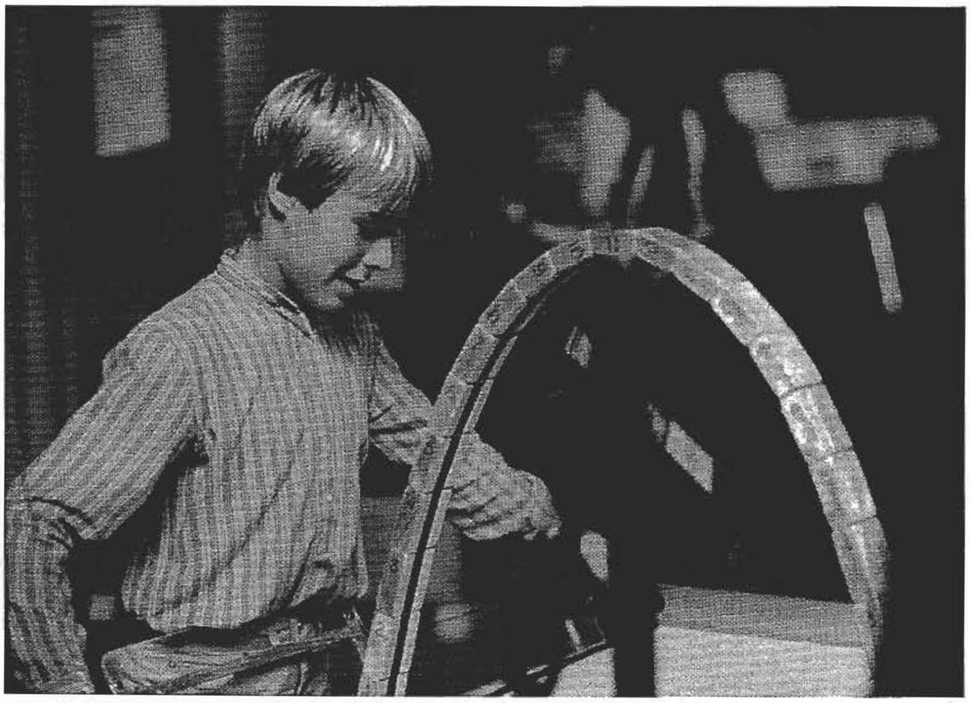


FIGURE 3. Catenary Arch exhibit at the Exploratorium, San Francisco.
Photo: Alan J. Friedman

with successful applications in industry and in everyday life.

EXHIBITIONS THAT FAIL TO MEET THE EXPECTATIONS OF ONE OR MORE COMMUNITIES

Quantum Atom Model (Figure 4, at the New York Hall of Science): A three-dimensional, interactive, dynamic model of quantum energy states of a hydrogen atom is very pleasing to scientists and serious students, but has proven to be difficult for the general public to appreciate or interpret. Too much prerequisite knowledge is required to understand why quantum theory was so surprising to scientists early in the century, and why the behavior it depicts is so radical and important to our understanding of the universe. The major intellectual achievement this concept represents is largely unknown to visitors. Visitors lacking some prior awareness of the revolutions in twentieth-century physics have a difficult time understanding what all the fuss is about.

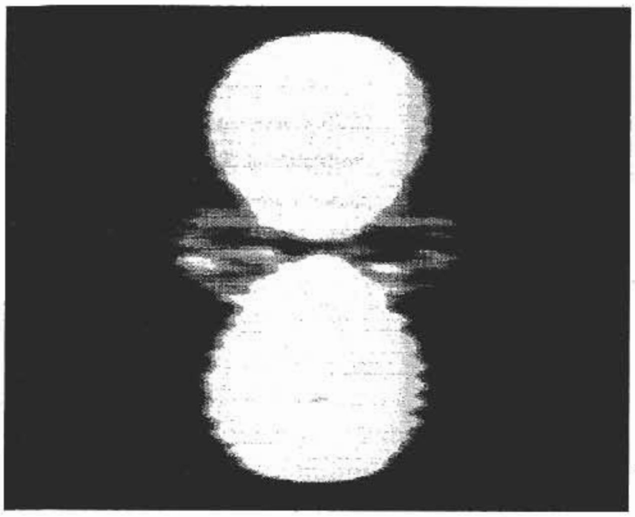


FIGURE 4. **Quantum Atom Model, part of the *Realm of the Atom* exhibition at the New York Hall of Science.**
Photo: Alan J. Friedman

Einstein (Figure 5, at the Exploratorium in San Francisco): Despite Einstein's fame and personal attractiveness to the general public, it has proven extraordinarily difficult to explain what he did to non-scientists. The science center most accomplished in presenting real phenomena in accessible form, the Exploratorium, was able to produce very little in the way of demonstrating Einstein's work itself. Its Einstein exhibition primarily presented phenomena that exposed inconsistencies in 19th-century theories. Most visitors, however, were equally unfamiliar with either 19th-century or 20th-century physics. Like the quantum atom model,

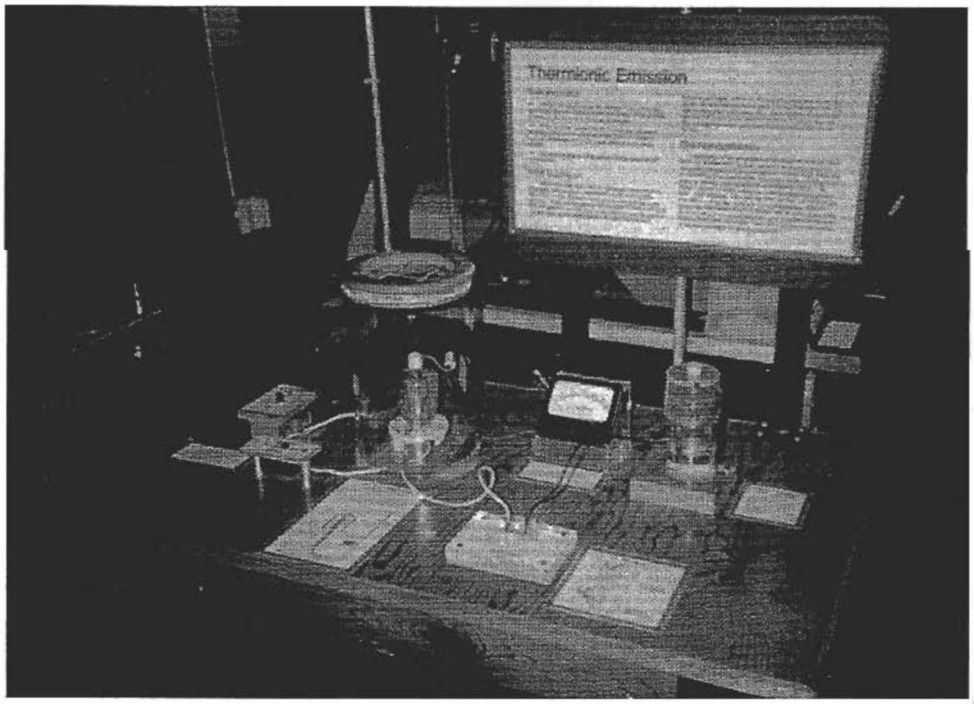


FIGURE 5. "Thermionic Emission," part of the *Einstein in Context* exhibition at the Exploratorium, San Francisco.
Photo: Alan J. Friedman

this exhibition is pleasing to scientists but of little interest to most of the public.

Enola Gay (Figure 6, at the Smithsonian's Air and Space Museum): The *Enola Gay*, the airplane that dropped the first atomic bomb on Hiroshima, is a concrete object representing a pivotal event in 20th-century history and in the entire history of the relations between science and society. The Smithsonian Air and Space Museum's attempt to place this object in a cultural and historic context led to threats to cut off government funding and eventually resulted in the resignation of the museum's director and the presentation of the airplane in a practically "interpretation-free" exhibition. While there were real intellectual disagreements about the best interpretation of the Hiroshima bomb, the failure of this planned exhibition was largely due to its failure to fit within the "celebration" expectation that funders and some sectors of the public audience regarded as the primary mission of this museum.[3]

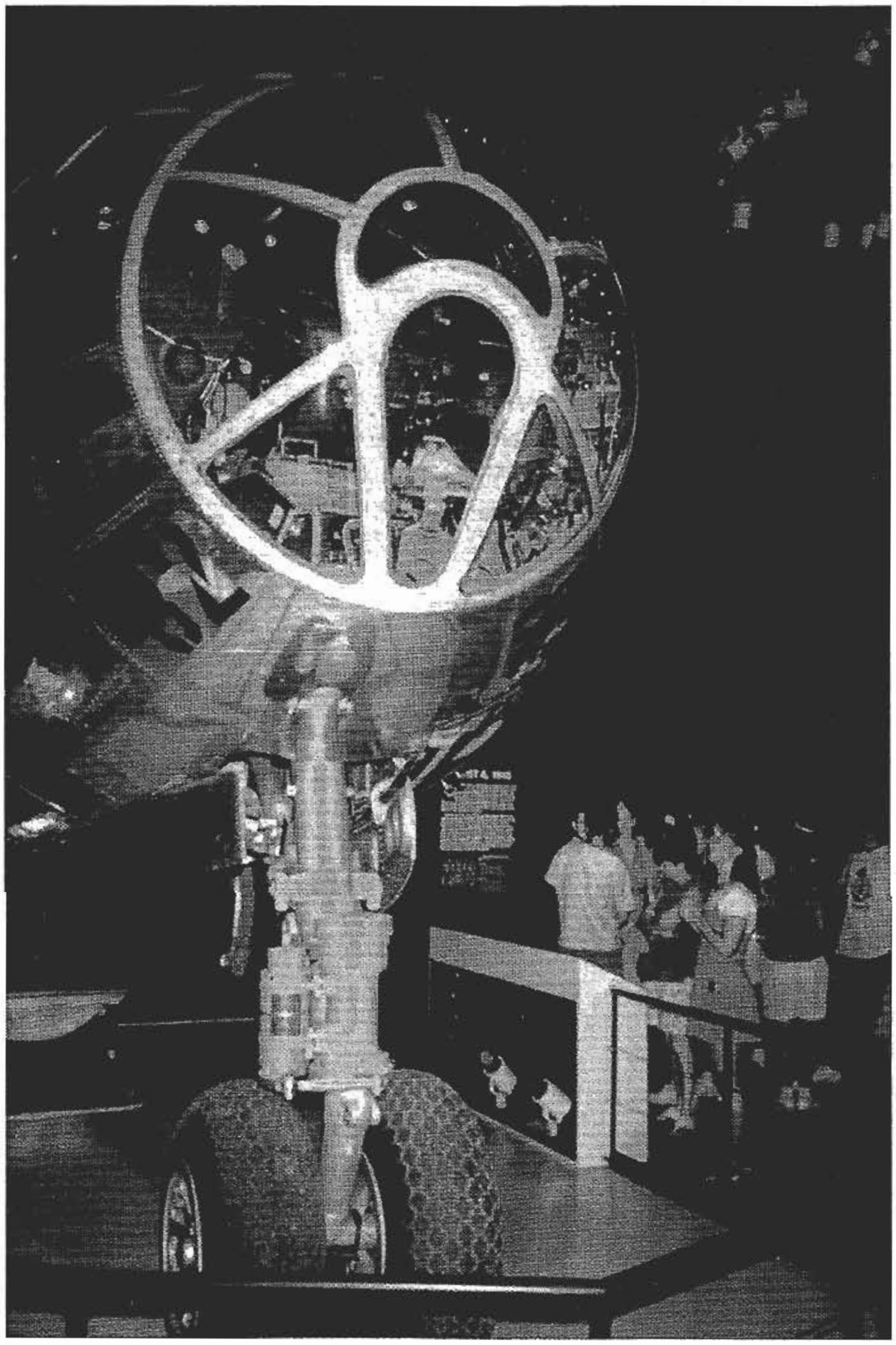


FIGURE 6. Enola Gay aircraft, part of the *Enola Gay* exhibition at the Smithsonian National Air and Space Museum, Washington, DC.
Photo: Alan J. Friedman

Science in American Life (Figure 7, at the Smithsonian's Museum of American History): This exhibition, like the planned *Enola Gay* exhibit, had similar problems. The curators had a particular view of one aspect of science in American life, a view that stressed the public's increasing disenchantment with science and technology as "cure-alls" for social problems. The major non-government funder of the exhibit, the American Chemical Society, had expected a celebration of the accomplishments that science had in fact achieved during the history of the United States, and were disappointed with the preponderance of negative examples that the curators used to make their more tightly focused interpretation clear. Members of the American Physical Society, a group of scientists who had not been funders, were even more outspoken in their criticism, vigorously articulating the view that the function of museum exhibitions is solely to celebrate accomplishments. While visitors to the museum were overwhelmingly pleased with the exhibition, rarely noticing its underlying theme, the unhappiness of scientists and scientist/funders created significant commotion and threats to the museum's funding.[4]

COMMON CHARACTERISTICS OF "SAFE" EXHIBITIONS

Success or disappointment with any given exhibition may certainly be related to the particular execution of that project, as well as its more generic properties. Such limitations notwithstanding, most successful universally pleasing science and technology center style exhibits have been essentially *non-verbal, non-sequential* experiences for visitors. In this fashion, they are more like art museums. Works of art themselves are largely meant to be non-verbal, non-sequential; so art museums can function merely by placing objects on walls, with little or no signage or context. The same thing can be done with the phenomenological exhibits at science-technology centers.

But science, especially contemporary advances in science of the type that win Nobel prizes, and understanding of cultural or historic context, are highly verbal (the language is sometimes mathematics) and require prerequisite, sequential knowledge to be understood. Objects like a computer chip, a telephone switching station, a recombinant

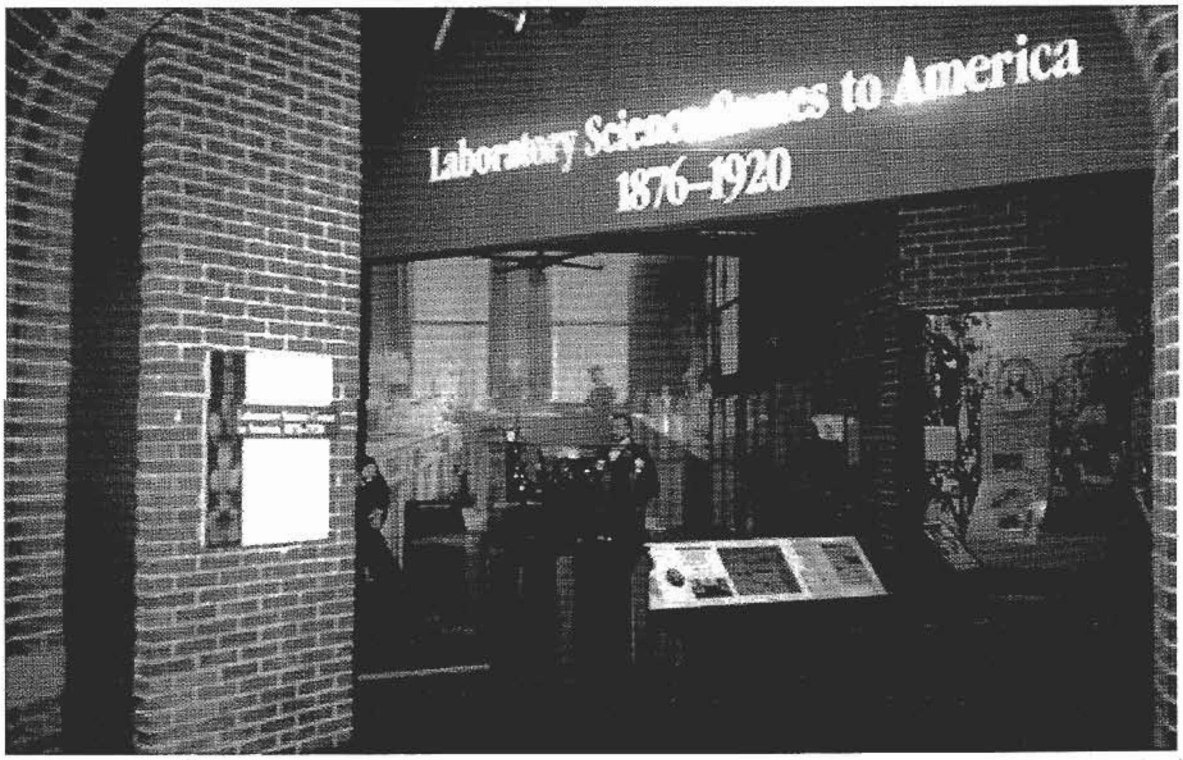


FIGURE 7. Laboratory Science Comes to America / 1876–1920, a section of the *Science in American Life* exhibition, Smithsonian National Museum of American History, Washington, DC. *Photo: Alan J. Friedman*

DNA laboratory, or a theoretician's brain do not "speak for themselves." So science-technology museums, and science centers in particular, have a very difficult time presenting contemporary science, the process by which science is done, or ideas about social context.

SUGGESTIONS FOR MOVING BEYOND CELEBRATION

There are many topics and goals for exhibits sought by scientists, scholars, funders, and the public that are extremely difficult if not impossible to communicate through the exhibit medium, and perhaps are just better suited to books, television programs, or formal classrooms. Nevertheless, science museums, to meet their own ambitions and those of their constituent communities, are attempting to move beyond celebration. One strategy to handle difficult topics and goals, including prerequisite knowledge and sequence, is to create simulations or even theme park rides, to impose an order to the visitor's experiences. But these presentations usually have low "reality quotients": visitors learn mostly about the rules of the simulation, not the rules of nature. These exhibitions may also break faith with the visitor's expectation that, in an informal learning environment, it is the visitor who should control the order and timing of the experience in the museum.[5]

There are, however, some possible solutions available that use science-technology museum strengths and still communicate effectively verbal, sequential stories:

- the use of multiple media so that the physical, three-dimensional objects in an exhibition and the labels do not have to carry the sometimes impossible burden of satisfying conflicting expectations. Random access and layered audio tours (**Figure 8**, New York Hall of Science), live tours, theatrical presentations on the exhibit floor; all allow more complex, multiple verbal perspectives to be offered and multiple agendas to be addressed, and early controlled experiments suggest these techniques can be effective.
- the creation of guided, longer duration, but still free-choice experiences, such as the experimentation galleries at the Boston Museum of Science and the Science Museum of Minnesota.
- exhibitions that make use of the social interactions among visitors and among visitors and staff, to explore contexts and controversial issues. "Mine Games" at Science World in Vancouver **(Figure 9)** has demonstrated the possibility of effectively dealing with conflicting interpretations

FIGURE 8. Visitors in the Seeing the Light exhibition at the New York Hall of Science, using a random-access audio tour during an evaluation study.

Photo: Teri Bloom

FIGURE 9. Section of the Mine Games exhibition at Science World, Vancouver.

Photo supplied by and used with the permission of Science World, British Columbia.

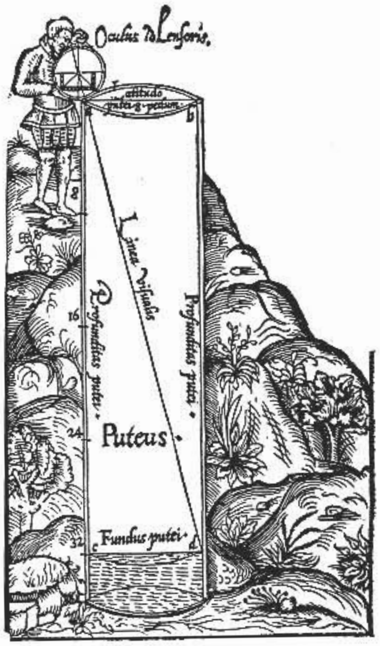
and biases in contemporary issues where science, technology, and other communities of interest meet.

Science museums are learning, albeit slowly and with some pain, how to combine the pleasures and successes of science-technology museum exhibitions with the inherently verbal, sequential structures required to go beyond the desirable but limited goals of celebration of science and of nature.

NOTES

A shorter treatment of this theme was given by the author for a panel at the 1998 meeting of the American Association for the Advancement of Science.

1. *Yearbook of Science-Center Statistics* (Washington: Association of Science Technology Centers, 1997), p. 19.
2. Valerie Crane, Heather Nicholson, Milton Chen and Stephen Bitgood, *Informal Science Learning* (Dedham, MA: Research Communications, 1994), pp. 61–106.
3. Mike Wallace "The Battle of the Enola Gay," *Museum News* (July–August 1995): 40–45, 60–62. See also Martin Harwit, *An Exhibit Denied: Lobbying the History of Enola Gay* (New York: Copernicus Books, 1996).
4. Jane Gregory and Steve Miller, *Science in Public* (New York: Plenum Press, 1998), pp. 214–219. See also Robert L. Park and Ursula Goodenough, "The Unmaking of American Science Policy: The End of the Scientific Era?" *Academe*, (January–February 1996): 15; Andrew J. Pekarik, Zahava D. Doering, and Adam Bickford, "An Assessment of the 'Science in American Life' Exhibition at the National Museum of American History," Institutional Studies Office, Smithsonian Institution, Report 95-5 (November 1995); Joan E. Shields, "Science in American Life Revisited," *Chemical and Engineering News*, (March 11, 1996): 40; Alan J. Friedman, "Exhibits and Expectations," *Public Understanding of Science*, Vol. 4 (1995): 305–313.
5. Alan J. Friedman, "Differentiating Science-Technology Centers from Other Leisure-time Enterprises," *ASTC Newsletter*, 24, No. 1 (1966): 7–10.



Beyond Understanding

CURATORSHIP AND ACCESS IN SCIENCE MUSEUMS

Jim Bennett

A museum of modern science presents a range of difficult challenges to its curators. Some are associated with the objects themselves, such as their size and safety, or their uninformative and unpleasing appearance. Others are administrative and financial, with cost commitments far outstripping any prospect of revenue. Still others concern public indifference, bafflement or suspicion. But one particular difficulty that curators will cite is public access, not just to the objects but to what they will call the "science." Science is difficult, obscure, complex, abstract and counter-intuitive. It seems all but impossible to take the lay visitor into a meaningful understanding of modern science. The idea of finding a "middle way" takes this as the central dilemma of science curatorship: very simple explanations are useless distortions, full explanations are impossible.

But is it really correct to think that our situation is any more challenging than that of many other museum curators? Consider the prospect of mounting an exhibition on state bureaucracy, contemporary warfare, newspaper production, transport systems, library management, and so on. How might we set about making a gallery presentation of a foreign language or a great opera house? There are many complex systems in the modern world, and many specialist understandings to cope with them, but it is in relation to science that in recent years there have been particular anxieties about "public understanding," and it has been in museums, or quasi-museums, that these anxieties have had their most visible effect. Museums of *modern* science are particularly implicated in this development, since the public understanding program is interested only in contemporary understanding. In fact, the characterization should be restricted further to contemporary understanding within a particular cultural context; the understanding being offered is bounded in time and in culture.

Everyone can agree that public understanding of science is a good thing. Public understanding of most things is a good thing, and museum professionals are in the business of promoting understanding for themselves, for their academic disciplines, for their specialist interest groups and for the general public. The problem is rather whether we can agree on the nature and character of this "understanding." The move from an unexceptional platitude to a program of action is too easily taken for granted and it is important not to allow particular interests and agendas to slip by uncritically; in this case these are embedded in assumptions about what constitutes "understanding."

One way of approaching the issue is to recall the influential remark of one of the founders of the science-center movement in Britain, Richard

Gregory, who declared that traditional science museums contained "remarkably little science."[1] At first sight, it is not clear what Gregory and other critics who followed this line could have meant. The museums and exhibitions they were criticizing were full of the tools and products of science, since these traditional museums tended to have rich displays of instruments and apparatus used in scientific experiment, in demonstration and teaching, and in the professional and industrial applications of scientific techniques. Was this not a display of "science"?

The critics felt they had two justifications for answering "no"—one temporal, the other conceptual. Part of the problem they saw was that these displays were overly focused on the past. But, more importantly perhaps, it was thought that there was something behind all this materiality, something structural, abstract and conceptual, something whose intellectual integrity was independent of these material relics and applications, and that something was the "science." The science could stand independent of such relics; understanding it would comprise, not a familiarity with things, but a grasp of concepts and their relationships. Even if this is a caricature that applies only to the more extreme positions adopted by these critics, it does represent the shift in emphasis and direction demanded and subsequently effected by the public understanding program.

To some extent, the approach to exhibition building offered as an alternative was advanced at the expense of the traditional museum values of the care and display of collections. There was, and sometimes there still is, pejorative talk of lifeless displays, silent objects, closed showcases, confined visitors, artifact fetishism, and so on. Interactives and "hands-on" exhibits were lively, engaging, even democratizing; more traditional displays were dry, austere and alienating.

But objections to presentation and display technique masked a more fundamental move to close down the range and scope of worthwhile "understanding." There are many ways of engaging with and entering into scientific culture, and the scientific relics in museum collections and displays raise many different kinds of questions about science alongside those concerned with how scientists codify and express their beliefs about the causal structures of the natural world. For a single-minded mission to explain "the science," objects are problematic because of their ambiguity and the richness of their associations for the viewer: their meaning and significance are not fixed, and visitors' reactions to them are difficult to control.

As nothing more than a parable, to illustrate the idea of closing down the range of understanding, we might take an example from one of the other subjects concerning difficult displays mentioned above. Imagine a visitor to an exhibition related to, say, European railways, a visitor with little or no relevant experience. Now imagine that the exhibition we have designed for this visitor presents a set of hierarchical, schematic maps of the railway network, and sets of outline timetables to show the basic structure of how the rolling stock is managed, perhaps with sub-sets of national and regional maps and schedules, offering more detailed case-history explorations of particular areas. Imagine that we have been clever enough to let the visitor try out a computer simulation whereby certain network configurations and timetable adjustments can be chosen and their consequences played out. Given sufficient application, it would be possible to emerge from such an exhibition with a fair grasp of at least the basic principles of such a system and a familiarity with some of its applications. No-one for a moment would judge that more than a very impoverished "understanding" of European railways would have been acquired. We would want our visitor to know something about trains, their locomotives and carriages, their manufacture, about the logistics of fuelling and maintaining the trains, the companies who run them, the government policies that legislate for them, the experience of passenger travel and its social implications, the economic significance of freight services, the history of network expansion and contraction, and so on.

As an alternative thought experiment, we might consider mounting a "science" exhibition about the distant past. Is it really a simpler task to introduce the visitor to, say, the medieval astrolabe? Compared with recent material, the technical content may well be very much more elementary, even though it still seems to baffle almost everyone, but many other interpretative problems have been magnified across such a distance in time. The disciplinary context for the instrument's use is quite unfamiliar, the social context for its commissioning, manufacture, retailing and possession are completely foreign, the functionality of the instrument is not what we are inclined to assume, the iconography is exotic, and so on. The interpretative advantage we may have gained in one respect has been at least offset by disadvantages in others, unless, of course, we restrict the "understanding" being offered to conceptual and technical matters, unless we value only a command of "the science" in the narrow definition encountered above.

The restricted notion of understanding that has been applied to many science displays allows the exhibition agenda to be carefully controlled. Exhibitions in every field adopt positions and postures, but outside science there is much more tolerance of visitors' own agendas and greater equanimity about visitors leaving unconvinced by or even hostile to the curatorial account of what they have seen. A sceptical visitor to an art exhibition is completely accommodated by the expectations of the occasion, on the part of the curator as well as herself. But a visitor can hardly leave a science exhibition saying that she did not "take to" the science on display and would have preferred a different one. Visitors know, of course, that this would not be a proper response, so instead they frequently *apologize* that they have not "*understood.*"

In a sense, and to a limited extent, we expect visitors to *become scientists*. We measure their success as visitors, and our success as exhibition builders, by how far they have been able to enter into the belief system characteristic of the science in question, to follow in the footsteps of those who actually make use of this system professionally. Again, we do not have similar expectations in other fields. It is of no concern to us if visitors to art galleries have made no progress as painters or sculptors. We would probably be surprised if visitors to anthropology galleries were moved to belief in an exotic religion whose liturgical artifacts were on display.

As for "democratization," we should distinguish between the packaging of exhibitions—the presentation and display technology—and their content. Certainly an inviting and engaging display will have the desirable effect of making visitors feel that the museum has something for them, and that, of course, is what we should be aiming at. But we surely cannot deceive ourselves into characterizing this as a democratic involvement with science. The educative experience offered to the visitor—the *content* of the display—is directional: it proceeds so far as is possible along a determined path. By setting the criteria of success, by prescribing a single agenda, by circumscribing the meaning of "understanding," we limit the possibilities for the visitor; we close off different responses to the collections held by the museum. This may be just what is needed for making people scientists of a sort, but we should not delude ourselves into thinking that it makes science more democratic.

Should we, on the other hand, think it strange that this closing down of alternative agendas has taken museums of science in a direction away from the museological concerns of professional curators in other fields? The debate elsewhere has involved the recognition that collections and displays have interests that can be located in history and in culture, that objects have meanings that are differentiated across contexts both outside and inside the museum, that exhibition agendas may well be unavoidable but can be recognized and conceded, and need not obligate the visitors, who can adopt alternatives.

Museological discussion in science has instead been more concerned with effectiveness. The new display philosophies were criticized, certainly, but at first on the grounds that they did not deliver what was promised. Having fun was all very well, but it no more delivered an understanding of "the science" than the static presentation of collections had done. It seemed to be taken for granted that there was an agreed end, and debate only over the means.[2]

Thankfully the museological debate in science is gathering strength and sophistication, and a series of recent anthologies has shown that commentators on museums and exhibitions in our field are prepared to take on more fundamental questions than how successful they have been at achieving their aims.[3] The most recent is a set of essays published in French under the promising title *La révolution de la muséologie des sciences*. Here James Bradburne, for example, who has been closely involved with the development of science centers, particularly and most recently with "newMetropolis" in Amsterdam, enumerates a set of criticisms of such institutions: that they communicate the principles and not the processes of science, they are "textes de physique en trois dimensions," they neglect the links between science and technology, and so on, and in general that the impression of exploration and discovery is bogus, since the underlying exhibition agenda is not negotiable: "Le message sous-jacent est que seuls les scientifiques sont en mesure de définir les objets de la science."[4]

Bradburne speaks of a "crisis" in science centers, one precipitated by falling visitor numbers. He believes that something new is needed, and he offers a critical analysis in which we find that there is already a category for something he calls the "traditional" science center—one where individuals confront isolated interactives in an arrangement that does not encourage discussion between visitors, one that insists on pure science even though visitors are more interested in its social aspects, and one that offers fun as a means of overcoming established antipathy to school science, but which at the same time is based on a similar schoolmasterly attitude to learning: "tout apprentissage est de type coercitif, du haut vers le bas." His summary characterization of the traditional science center is "un malheureux mariage de stratégies pédagogiques scolaires dans un environnement d'apprentissage non scolaire."[5]

The imminence of a new century seems to have encouraged other commentators in this volume to look forward to future institutions, to what might replace not just the traditional science museum, but the traditional science center. Emlyn Koster, for example, presents an account of science museums in three successive generations. The first is based on collections and the visitor's role is "regarder silencieusement des vitrines." The second—the present generation—is characterized by participation, movement, gadgetry and interactives. The third, it turns out, is more difficult to define and the characterization is nebulous, comprising pious aspirations rather than practical programs for realizing them. Whatever it is, people will be more important, society will be brought back into the scientific enterprise, science and culture will interact, and scientists and citizens will come together to face the technological and environmental problems of the twenty-first century. And whatever it is, some institution evolving from the science center will be at the heart of this new realization of a scientific culture.[6]

Museum taxonomies, developing over time, are offered by a number of contributors, with "generations" adopted as a common metaphor. Those identified by Bernard Schiele, for example, also number three, again with the science center as the second generation, giving way in its turn to a third, which again is a pious invocation of indisputably worthy things, such as wholism and integration.[7]

If we return to Bradburne, he too has ambitious expectations of the next generation of public institutions. In connection with the hopes for newMetropolis, we learn that it is tailored to a reformed society, not one comprised of producers and consumers, but "une société de personnes qui travaillent et qui choisissent." In such a society, the science center must be seen "non comme un sous-produit, mais comme un intermédiaire indépendant, qui favorise une pensée critique, curieuse et créatrice."[8] Bradburne says that museums and science centers have for too long operated in the shadow of the preoccupations of other groups, and that in the future they can have an independent role. But once again this useful idea is not cashed out beyond what can be read, to speak frankly, as a set of unexceptional platitudes.

Quoting from the founding policy of newMetropolis, Bradburne gives us some stirring ambitions for the future:

> De plus en plus, le centre scientifique offrira un cadre social que l'on ne trouve pas au foyer. Le centre scientifique sera un endroit de rencontre, de discussion, d'échange d'idées et d'information. Ce sera un lieu ouvert à tous, un forum, une place publique. Connecté aux réseaux d'informations internationaux, le centre scientifique deviendra un carrefour social et culturel, où les gens peuvent communiquer—seuls et en groupe—avec d'autres personnes de la région, du pays et des quatre coins du monde. C'est cette dimension sociale, dans son sens le plus large, qui distinguera le centre scientifique des autres possibilités qu'offrent la ville ou le foyer.[9]

How, in any practical terms, all this might be achieved by the third generation of science museums is far from clear; how the agenda of the science center is to be modified to take on this extraordinarily ambitious social program is not explained.

So, one of the strong impressions from this anthology concerns the need for the science center approach to move beyond entertainment and more effective elementary science education (though even that achievement is disputed) to something that might sustain an influential public culture of science. If anything, the effect of the common, second-generation, approach might have been negative in this respect, by offering a science that seems irredeemably juvenile, presented through primary colors, cartoon characters and playful interactives peddling a commensurate clarity and simplicity of vision. This science seems associated with the lost certainties of childhood, and nothing suggests that the public are inclined to relate these experiences to the real, complex, social and ethical problems faced by science as it is encountered in the grown-up world. There is no evidence that public confidence in science has risen over the period of rapid growth in science centers. If they were meant, as they surely were, to help restore the public's faith in scientific progress, and to make science a more attractive option to students and graduates, they have not succeeded. Perhaps it is enough that they remain facilities for rational entertainment and elementary education. But if science centers are to grow up, and contribute to a scientific culture that can compete in the complex and sophisticated adult world, it may be necessary to stop believing that lack of confidence is a matter of poor presentation by scientists and inadequate "understanding" by the public—the twin diagnoses that have yielded what we must now learn to call the "traditional" science center.

If it is possible to be heard across a generation gap, there are two things that might be said, as a more modest contribution to planning the scientific culture of the new century. Both address Bradburne's point that science museums should not be dominated by the preoccupations of others. The first is that scientific culture is rich and diverse, access is possible through many different interests and sensibilities, exhibitions can reflect this diversity, and their themes should not be closed down to the restricted agenda of the traditional science center. If that means that exhibition builders and visitors stray outside the narrow construal of "the science" that characterized the early years of the "public understanding" lobby, so much the better. The second point is that the discipline of *curatorship*, understood not in terms of the gratuitous caricature of the dusty scholar, but in the real, professional and creative sense that is well established in museum and exhibition work outside science, can give shape and substance to the pious hopes for the third generation. In conclusion, I will deal briefly with both these points.

There are many dimensions to the understanding of science, and many vectors of appreciation. The notion that the ubiquitous and multifaceted manifestations of science in modern society can or should be subsumed in an "understanding" of the conceptual apparatus employed by scientists, even if such a thing can be identified, seems almost ridiculous. Once we multiply the permitted modes of engagement with scientific culture—conceptual, of course, but also historical, material, aesthetic, commercial, social, ethical, geographical, institutional, political, and so on—the idea of "the middle way" seems flawed, or at least seems no more relevant here than in many areas of the museum world.

The second point concerns what we might actually do in these "third generation" museums, with their ambitious, honorable and woolly missions. Museums cannot operate effectively outside a disciplinary framework. They cannot simply take on some worthy but nebulous social program and change the world. But they can, and must, offer commentary, and in museums the disciplinary context for this is curatorship. While science museum staff need to be knowledgeable about science and history, curators must also bring an appreciation for material things, skill in the management of collections, and the ability to use objects powerfully and imaginatively in building exhibitions. The display techniques employed may well include computer technology and interactives, but these need not be used simply to present the preoccupations of others in an effective manner. The curatorial discipline has its own configuration of skills and sensibilities, and exhibitions should no more be history books in three dimensions than they should be physics texts.

Curatorship involves commentary, but at the same time it also entails a recognition that its medium, the museum exhibition, cannot really coerce. Visitors make choices, not only about how they move through the exhibition, but also about how they relate to the ambiguous objects and how they see their juxtapositions. The curator seeks to influence these, but they cannot be entirely under control. There is room for other agendas, and the best exhibitions stimulate and accept these alternatives. Insisting on "understanding," narrowly construed, involves condescension on one side and apology on the other. Creative exhibition curatorship, however, *enhances* access through alternative appreciations, and exhibitions of modern science can pursue these curatorial virtues just as much as treatments of the more distant past. The very ambiguity of objects, the unpredictability of visitors' engagements with them, becomes in this account of the science museum's future a virtue and a benefit, where formerly it provoked anxiety and banishment.

NOTES

1. This is discussed in Andrew Barry, "On Interactivity. Consumers, Citizens and Culture," in *The Politics of Display. Museums, Science, Culture*, ed. Sharon Macdonald (London and New York: Routledge, 1998), pp. 98–117 (p. 104).
2. See, for example, the papers in *Museums and the Public Understanding of Science*, ed. John Durant (London: Science Museum, 1992). An influential early critic was Michael Shortland, "No Business Like Show Business," *Nature*, 328 (1987), pp. 213–214.
3. See *Exploring Science in Museums*, ed. Susan Pearce (London: Athlone, 1996); *The Politics of Display. Museums, Science, Culture*, ed. Sharon Macdonald (London and New York: Routledge, 1998); *La révolution de la muséologie des sciences*, ed. Bernard Schiele and Emlyn Koster (Lyon: Presses Universitaires de Lyon, 1998). Relevant individual articles include Ghislaine Lawrence, "Museums and Science," in *British Society for the History of Science and History of Science Society . . . Papers for the Joint Conference, Manchester, July 1998* (Manchester, 1998), pp. 284–290; Alan Morton, "Tomorrow's Yesterdays: Science Museums and the Future," in *The Museum Time-Machine: Putting Cultures on Display*, ed. Robert Lumley (London: Routledge, 1988), pp. 128–143; Ghislaine Lawrence, "Object Lessons in the Museum Medium," in *Objects of Knowledge*, ed. Susan Pearce (London: Athlone, 1990), pp. 103–124; Robert Fox, "A Future for the Past: History and the Public Understanding of Science," *Deutsches Museum Jahresbericht 1997* (Munich: Deutsches Museum, 1997), pp. 19–22; Robert Fox, "Research and Curatorship in the National Science Museums: a Reflexion on Threats and Opportunities," *Impact of Science on Society*, no. 159 (1998), pp. 263–271.
4. James Bradburne, "Problématique d'une Création: newMetropolis," *La révolution de la muséologie des sciences*, ed. Bernard Schiele and Emlyn Koster (Lyon: Presses Universitaires de Lyon, 1998), pp. 39–77 (pp. 41–42).
5. Ibid., p. 55.
6. Emlyn H. Koster, "Vers une Éducation Scientifique et Technique Permanente," in *La révolution de la muséologie des sciences*, ed. Bernard Schiele and Emlyn Koster (Lyon: Presses Universitaires de Lyon, 1998), pp. 141–157.
7. Bernard Schiele, "Les Silences de la Muséologie," in *La révolution de la muséologie des sciences*, ed. Bernard Schiele and Emlyn Koster (Lyon: Presses Universitaires de Lyon, 1998), pp. 353–378.
8. James Bradburne, "Problématique d'une Création: newMetropolis," in *La révolution de la muséologie des sciences*, ed. Bernard Schiele and Emlyn Koster (Lyon: Presses Universitaires de Lyon, 1998), pp. 39–77 (p. 51).
9. Ibid., p. 57.