CRITIQUES AND CONTENTIONS

Dinosaurs and white elephants: the science center in the twenty-first century

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[Editor’s Note: Earlier this year (in Public Understanding of Science 7(1): 5-26), we published a perspective on science centers by John Beetlestone and others, explicitly asking others to continue the discussion. Given the central role of science museums and science centers in the general public communication of science and technology, we need reflections about their future often unavailable in the daily challenge of operating them effectively. Here, James Bradburne, a well-known critic and participant in the science center movement, contributes another perspective to the discussion. The questions he raises about the viability of science centers are fundamental to our understanding of the role of institutions of informal science learning in our societies. —BVL]

This paper argues that science centers are expensive to create as capital projects, expensive to maintain with professional staff, and, given the high costs of exhibit development, expensive to change. Lacking a fixed collection of unique artifacts with which to attract visitors, the science center is at risk when it cannot change quickly enough to meet the demands of its users. In the past, temporary exhibitions have been used as a means of creating more frequent change. Now, however, given the exponential increase of the availability of new electronic media, coupled with their massive interconnection via the Internet, informal learning can be had at home and in other sites, rendering the science center unwieldy, expensive, irrelevant, and obsolete. Threats to the science center cannot be lightly shrugged off, and a real transformation of the institution is required. The paper concludes that the science center, as an institution and as a building project, is doomed to extinction as a consequence of two factors—ecology and economy. It argues for the need to develop a new kind of institution of informal learning in its place.

Introduction

First, I welcome this open discussion about the future of the science center, in particular, and informal learning in general. The field has suffered for decades from the lack of real debate, fueled perhaps by the belief that the supporters of the science center movement—the NSF, local governments, and corporate sponsors—would withdraw their support if any sign of dissent showed in the ranks of the movement. Now, some thirty years after the opening of the San Francisco Exploratorium, I believe we are mature enough to encourage a critical look at our institutions, our field, and our performance.

Second, this paper contains my personal opinion, based on many years working in the field of informal education, and not the official position of the institution where I work. To understand my caution, consider my thesis: the science center as it is presently defined is a dinosaur threatened with extinction in the not too distant future, and the science center as a capital project is a white elephant that can only saddle the government with unrecoverable debts.
I have come to the conclusion that the science center is doomed the hard way—after spending nearly fifteen years working on new approaches to creating public informal learning environments, including museums, art galleries, World’s Fair pavilions, and of course science centers. Almost ten years ago, I attempted to sketch a provisional history of the science museum as an expression of changes in the history of ideas—notably in the history of science. I argued that the seventeenth-century emphasis on shared observation, an emphasis that largely defined the modern period, had profoundly shaped the development of all our institutions of informal learning, as the paradigm of the natural sciences was appropriated in every field of human activity. The resurgence of idealism in the twentieth century, in both philosophy and in the sciences, prompted a parallel transformation in the science museum—and I believed that we were witnessing the birth of a “third generation” of science museums, based on the active practices of doing science, rather than on the passive receiving of science as a canon of accepted truths. It was clear to me that we needed a new model for our institutions, based on the fully engaged activity of the visitor. I closed my 1989 paper by saying “Third generation science is an attempt to unhook the cart of absolute truth from the horse of enquiry, so visitors can leave not saying ‘I know,’ but rather ‘I know how to know.’”

Since 1989, a growing number of planners have championed the idea that our institutions of informal learning must undergo dramatic change if they are to survive and remain relevant in the next century. Over the course of the past nine years, often in collaboration with the Canadian anthropologist and museum planner Drew Ann Wake, I have been involved in a number of new approaches to the creation of informal learning environments. All of these approaches have stressed two key factors: “bottom-up,” or user-driven learning, and flexibility. The first factor means that the user must be considered the starting point for all effective learning; most science centers argue that interaction is enough, but in fact exhibits rarely allow visitors to actively shape the nature of their inquiry. The second factor stresses that our strategies, exhibitions, and institutions must be able to respond quickly and effectively to change. Most science centers recognize the need to change rapidly, but their focus on exhibitions means they cannot respond quickly or effectively. Many experimental projects have been developed to test the effectiveness of these two approaches. The Body in the Library, for instance, in which forensic science was cast in the form of a murder mystery, is now found in various forms in science centers from Sudbury to Copenhagen. Beyond the Naked Eye, an exhibition about medical imaging technologies, based on case studies and medical challenges, has been widely copied. Mine Games, an exhibition where the subject of earth sciences was transformed into a forum for debate on the future of the mining industry, was the focal point for social and political discussion about resource use in British Columbia for over two years. Finally, newMetropolis in Amsterdam opened this year as a challenge to the view that science centers should have science as their central concern.

Despite the success of these experiments, few science centers seem to have called their practices into question. New science centers continue to be planned based on the traditional pattern of clusters of hands-on exhibits about science and scientific principles (the single largest exhibit topic is physics), and existing science centers continue to develop exhibitions based on the assumption that physical interaction is a good thing, in and of itself. These traditional exhibit approaches share three signal weaknesses. They focus almost exclusively on principles and phenomena rather than processes, they misrepresent the nature of scientific activity, and they show science out of context—science defined “top-down” by scientists, rather than as experienced by visitors. Even when an institution tries to put science and technology into a social context, it is science and technology that is the point—not the
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The dominant model in which science centers "vulgarize" knowledge and make it available to the masses, or sugar-coat science with gratuitous hands-on interaction to arouse visitor curiosity, is rarely if ever questioned. As a consequence of its inability or unwillingness to change, the science center as an institution is now under attack—an attack signaled by falling visitor numbers and the recent closure of institutions such as Baltimore's Hall of Exploration. Its mission no longer meets the needs of society, its relevance to the public is diminishing, and it is being made superfluous by new communication technology.

These threats to the science center cannot be lightly shrugged off; a real transformation of the institution is required. If science centers cannot rise to these challenges, they risk becoming, like the planetarium before them, the "8-track cassette" of late twentieth-century institutions—a transitional moment, fundamentally flawed, and soon replaced by new technologies. After nearly ten years of trying to create a "third generation" science center, I can only conclude that the science center as an institution and as a building project is doomed to extinction, as a consequence of two factors: ecology and economy.

Dinosaurs

Let us start with the proposition that the science center is a dinosaur. Certainly the current building boom in America and Europe, notably in the United Kingdom, would suggest that the science center is alive and kicking. The number of science centers worldwide is growing, and there appears to be no end in sight. How could I possibly suggest that the institution is facing extinction? My metaphor is chosen deliberately. Dinosaurs became extinct for three fundamental reasons: rapid change in the climate, insufficient food to sustain their bulk, and increased competition from smaller, more flexible forms of life. In the same way, the life and death of the science center as an institution is a question of ecology, and its demise just a matter of time.

Let me review these three points in detail:

- **Climate:** the traditional science center mission is no longer relevant. In its modern form, the science center is a creature of post–World War II American society. Spurred by the Soviet conquest of space with Sputnik, stimulated by the race to put a man on the moon, and alarmed by the increasing public skepticism about the benefits of such scientific blessings as pesticides, nuclear power, and genetically altered food, government and industry supported the science center as a means of informing the public about science and technology. Like the dinosaur, the science center fit into an ecological niche—fed by government and industry in the lush tropical climate of the Cold War. Of course it was assumed that once understood, science and technology, and the interests that directed them, would be seen in a favorable light. Thus science center literature included statements like the following "Still, all too often do the negative aspects of science and technology get attention, and not their positive effects on society. In order for society to fully benefit from science and technology, accepting them is an absolute necessity. The applications in our daily life are often experienced as threatening and lead to the feeling of lacking knowledge. One tends to ignore science unnecessarily. [The science center] can play an important role in informing the normal citizen." Similarly, to fulfill its role, the science center's objective "is to excite interest in the basic principles of the natural sciences and the technological applications." The mission of the science center was to inform and convert, as learning about science and technology was seen as a prerequisite for citizenship. One of the leaders of the crusade, Jon Miller of the Public Opinion Laboratory at Northern Illinois University, commented "I doubt that anyone would argue that a citizen who failed the minimal set of items included in this
measure [of scientific literacy] would be very effective in following major issues in science and technology."¹⁸ Implicit in the enterprise was that the public was ignorant, and that the new science centers, with their emphasis on hands-on, interactive experiences, would cajole and delight the public into understanding, and thus accepting, the social program of those directing the scientific enterprise.¹⁹

Now at the threshold of the twenty-first century, with the Soviet threat collapsed, and the Cold War behind us, the traditional mission of the science center is no longer relevant. New challenges face society, and understanding science and technology, in and of itself, does not seem to hold out the key to meeting these challenges. As Jean-Marc Lévy-Leblond noted, being an engineer is no more necessary to taking a position on the use of nuclear power than being a lawyer is necessary to vote.²⁰ The issues facing the public are almost all social issues in which economics, ethics, and politics play as important a role as science and technology. The globalization of the economy has now shifted the emphasis from political to economic survival.²¹ In order to remain competitive in a period where the "high-volume" production is increasingly being done in countries with lower labor costs, industrialized societies must create a new "high-value" economy if they are to survive.²² Such an economy means a dramatically new approach to education, an approach in which informal education and a commitment to lifelong learning plays an essential part.²³ If countries like those of Europe and North America are to survive economically, they must become learning societies, and their institutions must turn their attention to the challenges of enhancing skills, rather than merely dispensing information and arousing curiosity. This change in economic climate has been understood by national governments and industry, and has been clearly signaled in the European Union’s "5th programme framework," which outlines the research and economic development strategy for Europe for the next four years, and stresses the importance of adapting to rapid change.²⁴ The traditional science center focus on scientific information is no longer tenable if the next generation is to keep up with the speed with which society is being transformed. Knowing how a telephone works is not going to help us—knowing how to use one is.

- **Resources: the institutional model is no longer appropriate.** In several key respects, the science center has grown out of the museum tradition. Broadly speaking, institutions of informal learning follow one of two models: the library and the collection. The library is a resource, and it puts the accent on use, especially directed by the users themselves. The organization of a library is a function of its use. The collection, on the other hand, is meant to be displayed, and its identity is bound to the collector, or more recently, the curator. The organization of a collection is a function of the messages its organizer wishes to communicate. The prime consideration of the library is the user; of the collection, the visitor. The science center has largely followed the model of the collection, despite the fact that one of the distinguishing features of these new institutions—hands-on science centers—is that they have no collection. The first of them, the so-called "second-generation" science centers, were, in effect, collections of physical principles and phenomena. The science center was "a forest of phenomena" in the words of Frank Oppenheimer, a place where the public could experience at first-hand real phenomena—spectra, electricity, inertia, and illusions that allowed the visitor to reflect on his own perception—that were increasingly being squeezed out of the classroom and out of daily life as well. Nevertheless, like museums with collections, the function of these institutions was to show, to display, and to illustrate.²⁵

Following the model of the collection came at a high price, that of dependence on visitors. A collection is visited, and once visited, the visitor’s task is fulfilled. The objects
in a collection are exhibited: displayed to a public that is often unable to engage with it due to lack of interest, inclination, or information. With their phenomena and principles enshrined in hands-on exhibits, their outcome repeatable and predictable, science centers' collections too are often exhausted by the visit. Notwithstanding the importance of the "affective" or emotional impact of the museum visit, several museum visitor studies suggest that most museum visitors come three times in a lifetime—as a child (often in a school class), as a young parent, and as a grandparent. This general pattern is of course mitigated to some extent by what the tourist industry calls "VFF" (Visiting Family and Friends); when your sister-in-law drops in with the kids, or your school chum passes through town for the weekend, a trip to the museum might be the perfect way to spend a Sunday afternoon. While it is true that schoolchildren often come more frequently, depending on the museum's outreach programs, these visits are often compulsory, and cannot be credited to the museum's attraction as an informal setting. However, notwithstanding VFF and visits, this three-visit pattern tends to force the science center to create temporary exhibitions as a means of generating repeat visits. In fact, the modern temporary exhibition is a creature born out of a desire to increase the number of visitors. In the 1970s, the great "blockbuster" exhibitions such as King Tut proved that the exhibition could also be a major money-earner, as well as a sure generator of extra visitors. Without change to generate repeat visits, or an influx of new visitors, the number of visits inevitably declines. Attempting to rely increasingly on transient tourist visits only compounds the problem by marginalizing the local audience. Paradoxically, however, increased visitor numbers impair the ability to deliver the high quality engagement that is at the heart of the museum, and science center, experience. Large numbers of visitors shorten and degrade every individual's ability to engage with the exhibits, and when international tourists make up the bulk of the visitors, the local community is squeezed out almost entirely. If the science center expands to meet the increased demand, it incurs increased operating costs that only make the problem worse—the dinosaur ends up being unable to feed its increasingly heavy bulk.

This is the crisis most science centers are now facing. Recent data published by the Association of Science–Technology Centers (ASTC) paints a picture of growing science center attendance. This is certainly true, if one includes the new centers and their visitors. But a closer look at the figures tells a different story. If the attendance to new centers is discounted, many science centers are seeing their visitor numbers fall annually—often dramatically in the case of "middle-aged" institutions. If these figures are then adjusted to eliminate the transient effect of temporary exhibitions, the picture is even bleaker. This suggests that the science center is becoming a victim of the institutional model it has chosen to follow. By defining its success in terms of visits, not use, the science center slowly exhausts its pool of potential visitors.

On the other hand, the library model is in a far better position. A library is both rooted in its community of users and global, in terms of the resources it makes available. As a resource center, it can service its users in a wide variety of ways. A library is not exhausted by a visit; on the contrary, it is refreshed by it. A library is used, and as long as the library provides resources and experiences—real or virtual—that are needed by its users, then its health is guaranteed. The model of the collection—particularly in an institution without one—cannot be remedied by money. It can only be remedied by change.

- **Competition: the institution cannot compete.** An institution can only survive if it provides a product or service unavailable elsewhere, at a competitive price. The traditional science center provided an environment in which visitors could manipulate simple interactive exhibits about the phenomena and principles of science. These experiences were largely
 unavailable in the classroom, and were novel and exciting to use. They were also very easy to imitate, desirable in a pre-Internet period, and, like a kind of educational McDonald's, there was an explosion of science center building that has still not ended. Now there are over 800 science centers worldwide, and nearly every major city has a science center. In these science centers there are experiences—for example an artifact or a demonstration of making a dam in running water—that cannot be replaced by new media. The power of a live demonstration cannot be replaced by a talking head on a 17-inch screen, whatever the inherent interest of the subject. However, hands-on interaction is not always enough to sustain engagement, and the science center is no longer the only institution to offer informal learning opportunities. It must now compete for the attention of its visitors with other informal learning resources—notably CD-ROMs, video games, and television—that are often far less expensive, and (better still) available at home on the Internet.

When many science centers were founded, the computer revolution had not yet begun. I remember as a young student going to the Ontario Science Center in Toronto to see their computers—computers for which they had paid a great deal of money. Some of these computers—the IBM 360 for instance—filled an entire climate-controlled room. No one imagined that within only a matter of years, the personal computer would invade the household. Certainly no one imagined the revolution brought about by the use of the Internet. Within a matter of years, broadband communication over the Internet will turn the home into a resource center for interactive activities: video-on-demand; networked games, discussion groups, forums, debates. The science center, lacking a unique collection to begin with, is now extremely vulnerable to the increasing ability of new technologies to bring to the home what was heretofore only available at the science center. The competitive pressure is enormous. Why go to a science center at all? And at prices that go as high as US$50.00 for a family of four, why pay for the privilege?

Nor is the science center the only institution of informal learning. Increasingly other institutions are providing high-quality learning opportunities outside the formal system: research labs, community centers, and libraries all provide workshops, lectures, and seminars. The entertainment giants like Disney and Spielberg have also begun to move into the field of informal learning, newly baptized “edu-tainment,” and Disney claims to create “an imagination-powered playsite where children and their parents can build important bonds through interactive and creative play.” The science center must now compete to deliver a unique and irreplaceable experience to all its potential users. As long as science center's remain wedded to their narrowly defined mission, they miss out on the opportunities to reach audiences not interested in science and technology as such, but rather interested in society as a whole—which includes issues such as environmental protection, genetic manipulation, euthanasia, urban development, and crime. As long as science centers continue to define themselves apart from culture as a whole, they risk losing out to other institutions and other interests. Like the dinosaur, the heavy and slow-moving science center is now threatened by smaller, lighter, more agile “institutions,” which stand to take its place in the ecology of informal learning.

White elephants

The above argument suggests that the science center—as an institution—is no longer able to meet the challenges that will face us in the next century, and will thus become extinct in due course. But what about the science center as a building project—a civic monument? If the life or death of the institution is a question of ecology, the decision of whether to build or not is a question of economy. Over the past several decades, we have experienced an explosion
of new museum—and new science center—building. With government supplying the cash and the clock ticking down to the year 2000 providing a symbolic deadline, there seems to be no slowing down in sight, as new projects in Britain, America, and Asia continue to near completion. The price of overbuilding in the museum community is already beginning to be seen, and cautious critics are already worried about the prospects for today's new science centers in ten years' time.7 The case against embalming the institution in a new, expensive, and inflexible building can be summed up as follows:

- **High capital costs.** The costs of any new building are high, and with the need to pay interest added to it, the cost of financing makes it imperative to build quickly and efficiently. A science center is a special kind of building, with special needs in terms of services and facilities, and special challenges to overcome in order to accommodate interactive exhibitions. Often special media are called for—IMAX®, OMNIMAX®, Showscan®, virtual reality caves—all of which represent a large initial investment and a high degree of involvement on the part of architects, designers, and planners. The architectural fees for designing science centers are high, and with the shortened building schedule, the risks are also high. The chances of a major science center project staying on time and on budget—however well managed the project is—are very slim. Added to this are the costs of exhibition development, which are a function of how much new design is desired. The greater the amount of prototyping, the greater the cost, the greater the risk, and the longer it takes. These capital costs are not normally recovered by the revenues generated by the project after opening.

- **High operating costs.** Once it is built and opened, the science center must be operated. Depending on the size of the center, this means a substantial investment in floor staff, workshop staff, administrative personnel, and maintenance workers, not to mention the costs of keeping a public building going—light, heat, water, power. The larger the institution the greater the investment in operations and the greater investment in personnel. The greater investment in personnel, the less flexibility the institution has when it comes to responding to fluctuations in revenue. The tail begins to wag the dog—programs are designed to keep staff in work, not to serve visitor needs. Attendance to a traditional science center is closely related to the weather—when it is raining visitors come in droves, when it is sunny visitors go to the beach. Unfortunately, the weather is not among the factors over which the science center can exercise much control.

- **High maintenance, and renewal costs.** Finally, due to the highly interactive nature of their exhibitions, science centers must devote a substantial percentage of their operating revenue to maintenance and renewal. More importantly, due to the nature of their exhibitions, renewal plays an important part in a science center's ability to generate new revenue. Science center exhibitions, however, are generally expensive and require specialized staff to design. Few science centers generate enough revenue to renew their exhibitions as often as would be ideal, and fewer still can afford to keep in-house the specialized staff required to design them. As a consequence, temporary exhibitions are brought in from other sources, or designed by outside firms, with a corresponding impact on the institution's budget.

Given the above, it is possible to argue that society should still fund new institutions of informal learning, albeit not necessarily science centers in the strictest sense. Funding an institution, however, does not mean funding a building project, and the reasons for building must be carefully considered. Institutions do not necessarily need new buildings. Projects around the world have shown that an institution can survive in makeshift or borrowed
surroundings, and take advantage of existing facilities to mount its exhibitions, workshops, and programs. Thus instead of spending a huge amount in “bricks and mortar,” badly needed capital can be supplied directly to projects and people.38 Why spend 60 percent of the investment capital on the building, when it could be going into programs? It could be argued that the capital costs are amortized over the life of the building; however, it can be argued equally that investing US$3 million/year in programs and temporary events for ten years could be just as wise an investment as spending $30 million to get the doors of a building open once.

A typical interactive science center exhibition costs about US$2,500/m².39 It must be built to withstand hundreds of thousands of visitors, and it must be expected to last two, three, or even more years. On the other hand, high-quality temporary exhibitions can be developed and built for as little as US$500/m²,40 and can be readily transported, repaired, and replaced. Even less expensive are programs intended for the Internet. Forums, discussions, and debates can all be prepared quickly and effectively with a relatively low investment of staff time. Creating interactive resources for the electronic networks—particularly broadband—holds out great promise for the future, as our institutions move away from the limitations imposed by physical buildings.

We know from the research of Marilyn Hood and others that for the majority of our visitors, the public physical space is one of the central motivations for visiting.41 Although it tries to, the Internet cannot replace real public space (not to be confused with the social space of dialogue, which can be very effectively supported by the Internet). The extraordinary variety of a two-hour visit in a public space, wherein one can read a paper, play a computer game, make a bridge out of blocks, have a coffee, kiss your sweetheart, or chat with friends, can never be rivaled by an experience circumscribed by a video screen. A public space is one which has other real, flesh-and-blood creatures in it, creatures demonstrably different from their e-mail addresses, opinions, or self-representations. However these may overlap in the virtual space of the Internet, the human body only exists in physical space, and the public human exists in a public space. However, a public space need not be a permanent space, as Ciencia Viva in Rio de Janeiro,42 Science Alberta, and the Palace of Miracles in Budapest have shown. Once freed from the burden of running a large and complex building, projects and programs can be developed that make the fullest use of human resources. A small core staff can manage a large number of initiatives. Temporary projects can rely on temporary appropriate staff, and longer-term projects can be structured to give the institution the greatest degree of flexibility. Why create an unwieldy and inflexible management structure, when increased flexibility is the only way to respond quickly to changing needs?

The reasons that could justify building a permanent home for a new institution vary widely, and are closely tied to local circumstance. In countries or cities where public space has been eroded by commercialization, road building, and changing demography, the new institution is an opportunity to create new urban social space. In Amsterdam, newMetropolis (my own institution) is a good example, where the building’s roof has created a piazza where people can stroll, look at the city, and listen to concerts. In other locations, a showcase may be called for, a place where informal learning practices can be seen, engaged in, and discussed—for example the Anacostia Neighborhood Museum,43 or the new Ars Electronica Centrum in Linz.44 In others, a building might be justified as a research center, a place where communities of learners can work together to generate new knowledge (or, in some cases, to generate real jobs, as at IDIS in Napoli or the Centre for New and Old Media in Amsterdam). In all cases, it is essential to separate the challenges of building an institution from those of making a building. Each has important, and sometimes sufficient reasons; however, one does not justify the other. I believe that the reasons to build new institutions
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outnumber those to build a building to house an institution. Some important initiatives
taken in recent years—such as CAST's children's science center in Beijing, or the Science
Alberta Foundation—have no permanent building, and instead appropriate for their activities
other networks and other buildings, such as research labs, daycare centers, libraries, and
hospitals. This in no way diminishes their effectiveness as institutions of informal learning.

To conclude, the crisis can be summed up as follows: institutions such as science
centers are expensive to create as capital projects, expensive to maintain with a professional
staff, and, given the high costs of exhibit development, expensive to change. Lacking
a fixed collection of unique artifacts with which to attract visitors, the science center is
at risk when it cannot change quickly enough to meet the demands of its users. In the
past, temporary exhibitions have been used as a means of creating more frequent change.
Now, however, given the exponential increase of the availability of new electronic media,
such as home computers, CD-ROMs, and soon, interactive television, coupled with their
massive interconnection via the Internet, the informal learning that once was the preserve
of the science center can now be had at home and in other sites, thus rendering the science
center unwieldy, expensive, irrelevant, and obsolete. In short, the science center is faltering
because, on the one hand (unlike the museum) it has little that is truly local—nearly
everything that can be found in one science center can be found in almost any science
center or on the Internet—and on the other hand the mission of the science center no longer
meets the needs of the world we are in the process of creating.

Towards a new institution

Do not want to end on a note of despair, however. When I wrote about the three generations
of science centers in 1989, I described the need for a new kind of institution. The subsequent
years have not prove me wrong. In fact, over the course of the past ten years we have
seen an increasing number of institutions, some of them housed in new facilities, that point
to the emergence of a new kind of institution of informal learning. Moreover, government,
cities, and industry are all signaling that they are in desperate need of such an institution,
either as an informal learning platform, and as a center for research. Now, at the threshold
of the twenty-first century, I believe the emphasis is fully on creating a learning society and
on how the learning process can be supported. A learning society needs new institutions
of informal learning, and institutions like Science North in Sudbury, the Science Alberta
Foundation, the Ars Electronica Centrum in Linz, the ZKM in Karlsruhe, and newMetropolis
in Amsterdam all represent a new approach to the challenge of creating public informal
learning environments.

Where I was mistaken was to see this new kind of institution as a necessary development
of the science center. We can easily imagine a world bereft of science centers—but it is
difficult to imagine a world without informal learning institutions. Instead I would now
argue that a new—and independent—form of institution is evolving from a wide range of
existing institutions, an institution in which the emphasis is on supporting self-initiated,
self-directed, and self-sustained learning in an informal setting. Not a science center, not a
museum, not a library, this is a new hybrid institution—a new learning platform.

What do I mean by informal, as opposed to formal, learning? And why do I stress the
difference? The key feature that distinguishes the museum from the school, or more broadly
the informal setting from the formal one, can be summarized succinctly in the words of
Frank Oppenheimer, founder of the San Francisco Exploratorium, one of the first and still
one of the world's most innovative science centers. He said "nobody ever failed a museum."
In a school, the student must be carefully qualified, in terms of prerequisite knowledge and
abilities, and carefully evaluated, in order to ensure the coherent and standardized acquisition of knowledge. In a museum, the visitor is defined by the act of visiting—there are no pre-visit qualifications and no post-visit tests. Our visitors are unknown, and, perhaps more importantly, unknowable. In the formal system, the student is responsible for learning. In the informal system, the institution is responsible for creating learning opportunities. A student can fail a school—but only the museum can fail its visitors.

The two systems, although complementary, are like oil and water—they do not mix. The formality we speak of in the learning environment is not just a question of style; of dusty classrooms and boring lectures versus interactive experiences and jolly good fun. An interactive program set in the science center, on whose success or failure a student passes, or fails, remains a formal experience—even if it is not conducted in the classroom. On the other hand, an evening lecture series in a classroom, voluntarily entered into and unrelated to passing or failing, is informal, wherever it happens to take place. Even though they often work in concert, and are both concerned with education, the formal and informal systems are distinct, independent, and parallel. The formal system thinks in terms of students, the informal system in terms of learners.

Why do these differences matter? What can the informal system offer that the formal system cannot? After all, it is often argued that in order to achieve its goals, all that is needed is more education, more hardware in the classroom, and more software to run on it. Following this logic governments should pour more money into the formal education system, not the informal one. What makes the informal sector worth the investment? The answer: The informal environment is a prime site for learning about learning and about learning to learn. I believe that new informal learning institutions offer two key features: research and reach.

First of all, research: Our informal learning institutions are potentially powerhouses of learning about learning. Only the informal environment can provide governments with proof of the effectiveness of new strategies to stimulate learning. On the one hand, if thousands of students go to classes every day, this does not demonstrate either the attractiveness or the effectiveness of the learning environment provided by the schools. Students go to school because they have to go to school. On the other hand, thousands of users daily “vote with their feet” and pay to engage in unforced learning. As long as we can ensure that learning occurs in the center, then learning it is, even if it is perceived by the visitor to be merely fun. When our learning environments attract users it is evidence for their ability to stimulate and structure self-initiated, self-directed, and self-sustained learning. When they don’t, our failure is public and painful. Success in attracting users is not enough, however. Michael Shortland’s famous question of 1988 still obtains: “But are they learning?” Although there is still substantial debate, there is now evidence that certain interpretive strategies can promote learning. If users come to our programs (proving their attractiveness), and they can be shown to learn (proving their effectiveness), then we can argue that we can have knowledge about motivation and effectiveness that can be transferred into the formal setting. If the knowledge we create in the informal setting can be transferred to the formal environment, then we have not only proven the worth of the informal environment, but enriched the formal environment as well.

Second, reach: The informal system potentially provides a means to catch the increasing number of people outside of the formal system—dropouts, the unemployed, the elderly, and ethnic minorities (among others). Because the informal system is by definition not restrictive, a broader spectrum of the public can find an opportunity to learn in the museum than in the school. Because it is concerned with learners not students, the museum can create a wide range of different learning opportunities for a broad number of people. This
reach is of enormous economic importance in the coming decades. As global finance and
new technologies change the face of the working world, and people have to adjust rapidly
to changes in the workplace, the informal learning environment becomes an important
place to learn new skills—not only the skills involved in new technologies, but skills of
communication, collaboration, and discussion. This socialization often has been associated
narrowly with the formal environment, but is increasingly a feature of the informal learning
environment, as the museum takes on the forum function in modern society. Whereas the
formal system sees its success in terms of more students, the informal system succeeds in
terms of more learners. To compete in the next century, we need more learners, not just
more students.

Interlude: one model

At the risk of hubris, let me describe one institution (my own) that is trying to act on the ideas described above: newMetropolis, Europe’s newest science center.

As an institution, newMetropolis is not a science center in the “traditional” sense. It is not solely about science and technology, and it does not have as its prime goal to transmit information about science and technology. It is an informal learning environment in which the emphasis is explicitly on developing new skills—such as abstraction, experimentation, collaboration, and systems thinking—that allow users to better deal with the rapid changes being brought about in large measure by advances in science and technology. It is a place where the human being—in the fullest sense—is at the center. It is a learner-driven environment in which the user can develop new skills to allow him or her to better deal with the challenges of contemporary society.

How can newMetropolis avoid the pitfalls of most other science centers, becoming neither a dinosaur of an institution nor a white elephant of a building? I believe that the answer lies in the way it was conceived, developed, and implemented, and especially in the way it conceives its mission. newMetropolis thinks in terms of users, not visitors. In focusing our development on groups that can readily come to newMetropolis, and creating experiences that can be returned to, we are less dependent on transient, expensive to get, tourist revenue (a repeat visitor costs four times less to attract than a first-time visitor). In this way, we are consciously moving the institution away from the museum model and towards the library model. newMetropolis is actively committed to change. Our institutions must change, and more importantly, be seen to change, in order to attract new visitors and to hold users. Traditionally, change has meant large-scale and expensive projects—new exhibits, new technologies, new exhibitions, new wings. From the outset newMetropolis has put an emphasis on easy and inexpensive change. Texts can be changed in three days at little material cost (and over 60 percent of the instruction texts have been changed since opening one year ago). “Pop-up” actors (our in-house street theater company) can change their acts in response to the news—daily if necessary. And of course newMetropolis’s own online information system, “Actua,” is updated daily as well.

Our institutions are sites for research into learning. newMetropolis was explicitly built as an experiment, and as a means of testing specific questions about interactive learning. The commitment to ongoing research is fundamental to the development of new products and programs (to meet the needs of new users), and to financial independence and stability (to ensure structural funding). At newMetropolis the real commitment to research, excluding floor staff who play an active role in new program development, represents nearly 30 percent of the total operating budget of the institution.

As a building product, newMetropolis is certainly subject to the critique formulated
above. newMetropolis cost a substantial amount to build (the construction cost was approximately US$20 million), and costs a substantial amount to operate (over US$5 million per year). It could readily be argued that newMetropolis equally could have found a home in an old warehouse or an abandoned building in the city center. This is perfectly true, and in other circumstances, lower cost and lower profile housing might be the appropriate framework for a new institution. However, as a building project newMetropolis can be justified as an experiment in urban planning terms. Its goal: to create new social space, to enlarge the city of Amsterdam. In creating a new social space, the new piazza of Renzo Piano gave newMetropolis the means to integrate itself into the social life of the city. By exploiting this “forum function”—by creating events, concerts, debates, discussions—newMetropolis can integrate itself into a much broader spectrum of free-time activity than the traditional science center.48

Financially, newMetropolis is fortunate to have been developed with multiple funding sources. No science center can survive if it depends solely on visitor revenue, and newMetropolis does not intend to be “self-sufficient” if that means 100 percent reliance on gate revenue. Too much dependence on an unpredictable and unstable source of income of necessity means compromising the long-term goals of the institution for short-term survival—not an option for an innovative institution of informal learning. One of newMetropolis’s strengths is its strong links to three key sectors of Dutch society—the state, the city, and industry—links based in part on its past as the Museum van de Arbeid (Museum of Labor). These triple links mean that the institution can be buffered financially and supported in its research and development goals.

But what about the “S” curve; the tendency for attendance to rise quickly then start to fall? Of course attendance can be expected to fall off in the medium term. The challenge is to flatten the slope of the “S”; to achieve that goal forms an explicit part of the mission of the institution. There is no guarantee of success—but unlike many new centers, confronting the issue from the outset is part of the core mission. newMetropolis, although it calls itself a science center for a variety of reasons, is really the model for a new kind of institution, and only the next ten years will prove whether it succeeds or fails.

Conclusion

So what approaches characterize this new institutional form we see emerging? Our museums and science centers must change if they are to meet the challenges of the next century. The next generation of new learning platforms will not necessarily be defined by their physical setting. They will not even need to have their own buildings. Our new institutions of informal learning—whatever their roots—will be characterized by the following features:

• Skills, not information. The new learning platforms must stress the acquisition of new skills, not just information. These skills are largely shared by art, science, and technology alike—creativity, collaboration, abstraction, thinking in terms of systems. The common ground provided by putting the accent on skills has the effect of making less important the distinctions formerly made according to content—science, ethnology, history, fine arts. Of course information is still indispensable, but it must be linked to the skills of finding, using, and appropriating that information. The new learning platforms recall the humanist education of the Renaissance, and prepare the learner for all fields of endeavor. As Jonathan Miller once said, they “prepare us for a world in which the life of the mind is a pleasure.”

• Turn visitors into users. The value of the new learning platform is created by use. Our institutions of informal learning must not be satisfied with the casual visit, nor driven by
The single-minded goal to increase the numbers of visitors through the turnstiles. The new learning platforms must draw lessons from the library, not only the theme park, and provide experiences that satisfy the full range of interests and expectations. A library is not judged by the number of tourists that visit, nor by the blockbuster appeal of its presentations. The new learning platform must create its base in the community, work with its local community to expand that base, and encourage repeat visits—real or virtual.

**High value, not high volume.** Our institutions must focus on creating a high value informal learning environment in all respects, and for all users. This means exploiting the specific strengths of all the media—real things for their immediacy and specificity, public space for its conviviality, computers for their ability to engage the player, the Internet for its access to global resources of both information and interaction. Exhibitions like Mine Games have shown that computer games are an effective way to create what Csikszentmihalyi calls the “flow” experience. Institutions like the Laboratorio dell’Immaginario Scientifico have shown the tremendous potential for creating linked group learning activities via the Internet. Institutions like ArsLab have shown the effectiveness of temporary manifestations. It is not the medium that matters most; what matters is that the quality and duration of the user’s engagement is maximized.

**Research and knowledge transfer.** A fundamental part of a new institution’s mission is to generate new knowledge about informal learning, and turn it into effective new tools for teacher training. This is a role that only a new kind of institution can play. By definition, informal learning is learning sought for its own sake—it must be self-initiated, self-directed, and above all, self-sustaining. Traditional, school-based educational research is unable to investigate these questions, as it has little or no access to a public environment in which learning is unforced. Publishers, on the other hand, are not geared to take risks in creating new educational tools, and lack the means of adequately testing their products prior to release. Only a public informal learning environment, with a stream of uncoerced users, can provide the research setting necessary to create the tools and the training so desperately needed by the schools and by society.

**Think global, act local.** A new learning platform must place its emphasis on what is unique to its specific locality, on what cannot be found or done somewhere else. It must put a premium on local culture, local practices, local experience. It must be firmly rooted in its local conditions, and use them to build a community commitment to the institution. In past decades, exhibits could not effectively be shared, so they had to be duplicated. However, new media and the Internet now allow our institutions to put the emphasis on local circumstance and local culture for the physical site—and global culture and global circumstance for the virtual site. Global information networks allow for the first time real, virtual institutions, open to visits from around the world, and to real-time participation. This participation need not be limited to the Web site itself. Exhibits can be designed that can be actively enjoyed by international virtual participants, as well as local users, and the participation of the virtual community can actively change the state of the local activity, much as an earthquake in Tokyo can shake the market in New York. By exploiting new media the physical scale of the institution can be tailored to local circumstances. The institution does not have to be a major capital project, unless circumstances demand it. It can be a rented storefront, a community hall, a borrowed lab—any space can be appropriated to become the kind of institution needed by the community.

To conclude, it is important to emphasize that the key to the survival of our institutions of informal learning—both as institutions and as real places—is in having the flexibility to respond to the needs of a wide variety of users.
An exhibit in the newly opened Ars Electronica Centrum in Linz provides an example of the direction our institutions must take if they are to survive. It is not the virtual reality cave, nor the myriad interactive computer exhibits. It is the virtual garden. In Linz there is a real garden, with real earth and real plants that grow in the real, local, Austrian sunshine. But this is a garden with a difference. It is planted, watered, and tended by a growing number of virtual gardeners via the Internet. This group not only tend their own plants but of course now communicate with each other—forming a virtual community. However, unlike most virtual communities on the Internet, such as newsgroups, this community's common object is real and local. The garden is, in a sense, the real consequence of a virtual world, a reality shaped and tended by a real group of caring gardeners. It is not difficult to extrapolate from this experience to the possibility of exhibit experiences being created in local environments but shaped by a global community of learners, each contributing and each being rewarded for his or her contribution. This kind of exhibit holds out the promise of realizing many of the approaches described above—it is local and global, it is user-driven, it transforms visitors into users, it is profoundly social and open to change. By turning our efforts to this kind of approach, the science center itself becomes a kind of virtual garden, wherein we all can play the part of gardeners.

Thus our institutions should take the initiative in developing new products and programs with new media. As specialists in the informal environment we are well positioned to take a leading role in creating new approaches to informal learning, and new knowledge about how to support learning. We may not be alone in the field, nor should we be, but the new institution's future is guaranteed as long as we continue to take the initiative in creating rich learning opportunities—inside and outside, within and without our walls.

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References


2. Bradburne, "Truth-Telling."

3. A critique of the prevailing "deficit model" of the public's understanding of science can be found in D. A. Wake and J. Bradburne, Fields of Knowledge (Paris: AMCSU/Infos printemps, 1993).

4. Many science center professionals might argue that hands-on exhibits are, by definition, "bottom-up" and user-driven. This contention is explicitly challenged in D. A. Wake and J. Bradburne, "Paradox Lost: Rediscovering Scientific Creativity," Alliage, no. 6 (1990): 17-24.


8. A complete account can be found in James Bradburne, "La problématique d'une création—NewMetropolis in Vers les musées du XXe siècle—La révolution de la muséologie des sciences: Nouvelles perspectives américaines, européennes et australiennes" ed. Bernard Schiele and Emlyn Koster (Lyon: Univ. of Lyon Press, 1998). The planners of newMetropolis would have a great deal of difficulty accepting the statement made by Beetlestone et al. that "Most visitors are intimidated by science. That's why science centers exist. Yet everything in a science center is, by definition, scientific"; see J. G. Beetlestone et al., "The Science Center Movement," Public Understanding of Science 7, no. 1 (January 1998): 5-26, on p. 8.

An evaluation of the pilot phase of a hands-on science center in the United Kingdom, conducted by a leading university research center in April 1988, was critical of the project on several grounds, but particularly for fragmenting and decontextualizing scientific subject matter. It provided some advice: "It might well be the case the developers will wish to be more selective of content in the future, as the public's response and the effectiveness of various types of experience are better understood... For example, under the umbrella of science and technology are included experiences involving obvious scientific principles, less obvious technological applications, examples of measuring techniques, visual illusions, spatial problems etc. All these experiences might well be fascinating and capable of arousing curiosity. Their effectiveness in supporting the exhibition objectives is not always self-evident. One of the difficulties of presenting a range of experiences to the public in a context such as [the science center] is that there is no obvious linking concept to help people make sense of their experiences. Without such a strong background context, there is a danger of the experience becoming fragmentary, and consequently trivialised."

For a thorough and detailed discussion of the relationship of science studies to the science center, and of the science center's relationship to science, see B. Regeer, "Two Paradoxes and a Triangle: The Public Understanding of Science Exhibited" (master's thesis, University of Amsterdam, Department of Science Dynamics, 1996).

The effectiveness of hands-on exhibits in terms of learning, and the response that they are intended to trigger, rather than communicate, is made clear in the evaluation cited in note 10: "As might well have been predicted, the sample visitor responses also indicate that in one or two exhibits, including some of the more popular ones—"Bernoulli Table," for example—there was little understanding of the scientific principle which explains the phenomenon presented. This is not to suggest that there should or could have been understanding.... For example, in some cases, visitors were provided with useful intuitive experiences which they could not be expected to describe or understand, but which might provide under-pinning experiences supporting later understanding." The increasing importance of constructivism in the science center debate in recent years, championed by planners such as George Hein, has called many of these approaches into question. Moreover, debate in the related fields of the public understanding of science, science dynamics, and the sociology of science have focused on the inadequacy of the traditional institutional approaches. Despite these critiques, many institutions remain committed to the traditional hands-on approach pioneered in the late 1960s, based on an implicit reception theory and an unreflectively realist position. See the articles in Visitor Behavior 12, nos. 3 and 4 (Fall/Winter 1997).

A report on the closure of the Columbus Center's Hall of Exploration due to inadequate visitor numbers (it attracted only 70,000 instead of the projected 280,000) can be found in the ASTC Newsletter 26, no. 1 (Jan/Feb 1998): 1.

This phenomenon is shown graphically in Beetlestone, "The Science Center Movement," p. 6.

ASTC reports that in 1990-1996, 86 new science centers opened, more than in the entire previous decade; see Yearbook of Science Center Statistics. (cited in note 9).

Netherlands Instituut voor Nijverheid.en Teckniek (NINT, immediate predecessor to newMetropolis), annual report, 1984.


The mission of the science center to "beguile" the visitor into engaging with science (in the words of former Techniquest director John Beetlestone) can be seen in the Techniquest mission statement, where the goal of the exhibitions is "to engage, to amuse, and to engender a sense of fun in the exploration and understanding of the world around us." Techniquest, mission statement, 1988.


This argument is made at length in J. Douma, Prototyping for the 21st Century (Amsterdam: newMetropolis, 1994).

"The reason for writing [the Discourse] has been primarily to develop a vision to guide our development. For we truly believe that we cannot simply build a Science Center without having reflected as thoroughly as possible on what role this new center should and could play in our present and future society. Science centers and museums alike have always been children of their time and this infant of ours should be able to participate in societal life for as long as possible." Douma, Prototyping for the 21st Century.

The draft framework document was presented in Fall 1997, and is to be published in Fall 1998.

See K. Hudson, A Social History of Museums (Atlantic Highlands, N.J.: Humanities Press, 1975) and
27 This is of course not true for all science center exhibits, and much of the work of the past three decades has been to create exhibits which allow real interaction, leave room for the visitor to ask and answer their own questions, and truly engage with the material. Sadly, many, if not most, science center exhibits are still just devices that allow the visitor to set into motion principles or phenomena that someone finds interesting. This so-called “hands-on interaction” merely turns the user into an extension of the exhibit, a soft hand to baffle the developer of the exhibit. It is often an emotionally-charged, social occasion in the company of family and friends accounted for in large measure for the observed frequency, and that even repeat visits based on this affective charge merely reinforce the pattern of visits.

29 As an example, in 1997, over 85 percent of the visitors to the Van Gogh Museum in Amsterdam were foreign tourists.


33 Evidence of this phenomenon can be found in a privately commissioned feasibility study conducted for Erlebahn Wien by Ravest Associates in conjunction with Drew Ann Wake and the author.

34 See Drew Ann Wake’s contribution to the debate in “Are Science Centers Doomed?” The Informal Science Review, no. 20 (1996): 2–3, which sets out many of the arguments made in this paper.

35 This message has not yet gotten through to many in the field, and the science center is still thought to be the vehicle for launching and demonstrating new technologies. Nora Lee, editor of the education trends magazine E-Zone, writes “Science centers have always been on the cutting edge, particularly in presenting new technology to the public.” This statement betrays a certain confusion between the role of World’s Fair temporary events that have traditionally been the launchpad for new technology, and science centers, which by the fact of their permanence, cannot keep up with the pace of replacing new technologies with even newer ones.


37 Museums built in the 1980s, such as the Frankfurt Museum für Kunsthandwerk (housed in a striking Richard Meier building), are already seeing their visitor numbers fall substantially, and the lottery-funded Bristol 2000 project has already forced what some observers believe is effectively the closure of Britain’s oldest hands-on science center, the Bristol Exploratory, causing speculation about the negative impact on smaller, community centers by large new-build projects.

38 Unfortunately, the opposite strategy—to fund “bricks and mortar” at the expense of programs, seems to be the norm, even in countries where investment in people would seem to demand the higher priority. Bruce Lewenstein recently visited Asia, and his report highlights a common finding that many Third World governments prefer to build monuments instead of creating new institutions of informal learning. “After a small start several years ago, the Indonesian Science and Technology Center opened in November 1995. It occupied a brand-new 24,000 sq-meter, 3-story facility in the Taman Mini Indonesia Indah... reputedly Indonesia’s most popular attraction. The science museum is open, but still only partially full. It has about 200+ exhibits. Some were built by [a government agency’s] institute on instrumentation and standards, relying on the “cookbooks” produced by the Exploratorium. Some were bought from science museums in Australia. Some are donated from companies; a few of these appear to be designed for interactive science museums, but many appear to be last year’s trade show booths, ranging from a BMW exhibit touting its new aluminum drive shaft to...
Dinosaurs and white elephants

a British defense contractor's exhibit on the lethality of its missiles. Although the museum staff had hoped to group exhibits into four areas (transport, life sciences, telecommunications, and energy), the exigencies of which exhibits they could produce, fund, or borrow have led to something of a mish-mash.... [The director of exhibits and education] said they are now in the process of trying to regroup the exhibits to create some coherence. Nothing she said implied that the museum has a clear long-range plan of how to build its collection of exhibits systematically. She knows that many of the exhibits provided by companies are inappropriate both in tone and design for the science museum, but accepts that for the near term she will have to work with what she can get. (Unpublished report, August 1996). See also J. Bradburne, Informal Science in Jordan (UNESCO Technical Report, Paris, 1993).

Based on the author's experience on numerous science center projects.

Our target—successfully met—for the exhibition "The Body in the Library," which opened in Calgary, Alberta, in 1993, was CDN$500/ft² (equivalent to US$385/m²).

M. Hood, "Leisure Preferences are the Key to Science Center Audience Research" (paper presented to World Science Center Congress, Vantaa, Finland, 1996).


The Anacostia Museum was developed by American psychologist Dr. Caryl Marsh for the Smithsonian Institution in the 1967, and was the first such museum in a predominantly black neighborhood.

See G. Stocker et al., Ars Electronica Center: Museum of the Future (Linz: Ars Electronica Centrum, 1996).


Since it opened in June 1997, newMetropolis has been conducting active research into the effectiveness of its exhibition strategies. This research is due to be published beginning in late 1998.


For a contrast, consider the New Jersey State Aquarium in Camden, New Jersey, USA. Built to anchor the redevelopment of a barren waterfront in an impoverished town, the institution draws only 60 percent of its breakeven needs because of the lack of other activities near it—it has no way of integrating itself into community life (Bruce Lewenstein, personal communication, April 1998).


Preliminary data indicate that newMetropolis visitors spend substantially greater amounts of time engaging in the exhibits than at any other institution for which we have data. The average visit to newMetropolis is more than four hours—a substantial investment in time for only 5000 m² of interactive exhibitions. Moreover, data also suggest that despite the emphasis on games and game playing, users do make the connection between the game activity and related social and technological issues.

In a recent project sponsored by a government ministry, Dutch citizens were asked to "vote" on their choice of planning strategy for the future of the country in 2030. After substantial publicity, over 1600 written ballots were sent in from throughout the country. To coincide with this event, newMetropolis designed an interactive video debate on four of its "Actua" computers. In this debate, users could watch short video clips promoting different positions, and having heard at least four opposing positions, could vote. In the two months of the national poll, over 2700 "votes" were cast at newMetropolis—more than half of the entire poll!! The complete data from this experiment will be published in late 1998.

The 18 "Actua" computers at newMetropolis provide both open access to selected Internet information providers and an extensive collection of sites linked specifically to each of newMetropolis's 150+ exhibits. During an average week (about 6,000–7,000 visitors), approximately 55,000 pages of information are consulted.

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