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ABSTRACT

This issue is a debate-discussion concerning science centers in the electronic age. The articles are based on presentations made at the Science Center World Congress (1st, Heureka, Finland, June 13-17, 1996). The four articles are: (1) "Lessons from Laboratorio dell'Immaginario Scientifico" (Andrea Bandelli); (2) "The Doom-Shaped Thing in the Kitchen: The Future of the Science Center in the 21st Century" (James M. Bradburne); (3) "Science Centres and Museums in the Electronic Age: Are We Doomed?" (Roland Jackson); and (4) "The New Informal Science Education" (Drew Ann Wake). The first and fourth articles claim that the electronic revolution has rendered science centers outdated and anachronistic; the second and third articles argue for the continued relevance of the science center experience. (DDR)

Science Centers in the Electronic Age: Are We Doomed?

Robert L. "Bob" Russell
Co-Publisher/Editor

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The Informal Science Review - No. 20, Sept./Oct. 1996

INFORMALSCIENCE

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SCIENCE CENTERS IN THE ELECTRONIC AGE - *ARE WE DOOMED?*

Robert Mac West

The First Science Center World Congress convened at Heureka, The Finnish Science Center, June 13-17, 1996. Over 500 delegates from 48 countries enjoyed a smorgasbord of plenary sessions, demonstrations, symposiums and formal presentations.

Among the more interesting sessions I had the pleasure of attending was a "debate" titled Science Centers in the Electronic Age - Are We Doomed? It featured two protagonists who claimed that the electronic revolution has rendered science centers outdated and anachronistic and two who made passionate arguments for the continued relevance of the science center experience at a time when people are becoming increasingly disconnected from each other.

Andrea Bandelli of IMPULS, Amsterdam, and Drew Ann Wake of Livewire Designs, Vancouver, argued for the brave new electronic world; James Bradburne of IMPULS and Roland Jackson of the Science Museum, London, made the case for the human experience.

All four contributors graciously made written versions of their comments available to **The Informal Science Review** so we can bring you this debate-discussion of a technological development which is affecting all informal learning organizations in one way or another.

These papers were lightly edited to bring them into grammatical usage and spelling uniformity without altering the authors' intentions. I remind the readers that because these comments were presented as an informal debate, some of the positions are somewhat more dogmatic and arbitrary than the authors truly believe.

THE USE OF INFORMATION TECHNOLOGIES IN INFORMAL SCIENCE EXHIBITIONS

Robert L. Russell

"Info Tech" exhibits, such as interactive computers, multimedia, and virtual reality, are commonplace in science museums, zoos, and like institutions. Now, many of these same institutions have their own Internet Web pages, filled not only with basic information on their programs and services, but often rich with educational resources.

In this article, we will focus on how information technologies can be effectively used in exhibit environments to support learning by visitors. Visitors most likely visit science centers, zoos, and natural history museums to experi-ε ' things (living things, phenomenan, or objects) uncommon in their everyday lives. What role should virtual reality and other "unreal" experiences play in an exhibition?

To help us answer these questions, we will first review how these technologies are currently being used in exhibit environments. After a general overview of Info Tech exhibits, we will take a more specific look at several types of information technologies: (1) databases, encyclopedias, and electronic books; (2) quizzes, puzzles, and games; and (3) visualizations, simulations, and virtual reality. Following a discussion of learning from interactive information technologies, the report will conclude with observations on the role of information technologies in exhibit environments and related design considerations.

An overview of Info Tech Exhibits

The broad range of Info Tech exhibits illustrates many different ways they may be used in science museums.

See "Information," continued on page 8

GOOD NEWS ON THE FEDERAL BUDGET

On October 1 (the first day of FY 1997), Congress passed legislation which includes appropriations for NSF, NEH, NEA and IMS, while leaving NEA and NEH unauthorized.

The Institute of Museum Services now is joined with a public library program formerly in the Department of Education as an independent agency, the Institute of Museum and Library Services. The library program paases $136 million to state library agencies, an increase of about 4% over 1996; museum funding increases to $22 million, $1 million more than in 1996.

The new agency will retain separate boards for its two branches, funds will be appropriated separately, the directorship will alternate between persons

See "Budget," continued on next page

"Budget," continued from front cover

with library and museum backgrounds, and two civil service positions are created for deputy directors for museums and libraries. The new Office of Museum Services is identical to the old IMS in terms of staffing and programs; the mission is altered slightly to include promotion of joint museum/library projects.

The Informal Science Education program at NSF is funded at the same level as last year, $36 million. The Administration's budget request had been for $26 million, so Congress overturned that proposed cut. The quid pro quo is that $10 million of ISE money must be spent on efforts that promote systemic education reform. The entire NSF education budget was increased by 3% to $619 million, within an overall NSF increase of 1.5%.

Both NEA and NEH are funded at the same level as 1996, $99.5 million for NEA and $110 million for NEH. Both houses of Congress originally had proposed reductions for NEH.

In other agencies, the Telecommunications and Information Infrastructure Assistance Program will receive level funding at $21.5 million. The charter school program, which funds planning grants, increases from $18 million to $51 million. Goals 2000, which sends money to states and local school districts to promote school reform, increases 38% to $491 million.

Finally, Congress has chartered a new private organization, the U.S. National Tourism Organization to replaced the defunct government U.S. Travel and Tourism Administration. Both the American Association of Museums and the National Trust for HIstoric Preservation will have seats on the 45-person board.

Several national associations worked very hard to encourage this favorable budget outcome. Government relations offices at ASTC, AZA and AAM deserve great credit for their efforts, supported, of course, by their thousands of institutional, commercial and individual members.

Information: Ellen Griffee, ASTC, 1050 Vermont Ave., N.W., Suite 500, Washington, DC 20005; (202) 783-7200. Jane Ballentine, AZA, 7970-D Old Georgetown Road, Bethesda, MD 20814; (301) 907-7777. Amy Finch, AAM, 1575 I street, N.W., Suite 400, Washington, DC 20005; (202) 289-1818. - RMW

FAMILY LEARNING IN SCIENCE MUSEUMS

A one-day workshop, held on Monday, February 3, 1997 at Cornell University in Ithaca, New York, will focus on family learning in museums. Workshop presentations and breakout sessions will address issues involved in developing exhibits and programs that encourage family interaction and learning.

The workshop will feature presentations by Dr. Urie Bronfenbrenner (co-founder of the Head Start program and Professor Emeritus, Department of Human Development and Family Studies, Cornell University), Minda Borun (researcher on family learning at the Franklin Institute Science Museum, Philadelphia), and Dr. James Garbarino (Director, Family Life Development Center, Cornell University). During the afternoon, participants will engage in discussions and exercises to evaluate exhibits and programs for their ability to encourage learning in family groups.

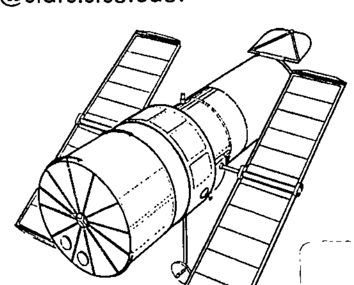
Details: Charles Trautmann, Sciencenter, 601 First St., Ithaca, NY 14850; e-mail, cht2@cornell.edu; telephone, (607) 272-0600; fax, (607) 277-7469.

ASTRONOMICAL SOCIETY OF THE PACIFIC OFFERS NEW MATERIALS

RealSky CD is a set of eight CD-ROMs which offers single-color images of the entire northern sky, down to -15 degrees and angular resolution of 1.7 seconds, revealing stars as faint as the 19th magnitude. Available for either Windows or Mac at $250 plus shipping and handling, it is packaged with a manual and accompanying software.

ASP also has two new slide sets. The Hubble Spaces Telescope #5: What a View includes images of stars forming gaseous pillars in the Eagle Nebula, Seep Field images that reveal thousands of galaxies, a mosaic of the Orion Nebula, the Egg and much more; the 20-slide set costs $26.95 plus $5.00 shipping and handling. Splendors of the Universe #5, 15 slides, includes the Pencil Nebula in Vela, the Sombrero Galaxy, Barnard 86, and an assortment of planetary nebulae for $22.95 plus $5.00 shipping and handling.

Orders: Astronomical Society of the Pacific, Orders, 390 Ashton Avenue, San Francisco, CA 94112; (415) 337-1100; fax (4115) 337-5205; e-mail asp@stars.sfsu.edu.



INFORMAL LEARNING ENVIRONMENTS RESEARCH

A new Special Interest Group is forming within the American Educational Research Association (AERA). An organizational meeting for the Informal Learning Environments Research Group will be held at the 1997 AERA Meeting in Chicago. One need not be a member of AERA to join this group or receive its newsletter.

Information: Christine (Kit) Klein, Ph.D., St. Louis Science Center, (314) 533-8283; fax (314) 289-4420; e-mail <kklein@slsc.org>

FROM THE EDITORS

Capitalism is probably the most revolutionary social force. Our lives are characterized more by constant change than by stability. We are now debating issues such as the ethics of biotechnology and surrogate birth, while deciding whether to wait on faster Internet access via cable television or to get the fastest modem now available.

Capitalism gave birth to some of the first science centers in the U.S. The Museum of Science and Industry (Chicago), the Pacific Science Center, and the New York Hall of Science all have their origins in World's Fairs. The industry is now challenged by new forms of entertainment, available not only in theme parks and family/adult entertainment centers, such as Dave and Buster's, but also at home.

We believe that science museums, zoos, and like institutions can survive in this modern and competitive environment. Survival must involve emphasizing the real reasons people come to science museums — to see real objects, to experience real phenomenon, to see living things.

Technology is not a panacea. We believe that, if used judiciously, it can be a major strength in exhibition interpretation. We hope that the Helsinki debate and related article by one of us (Russell's article on Info Tech exhibits) will help you reflect on these issues.

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LESSONS FROM LABORATORIO DELL'IMMAGINARIO SCIENTIFICO

Andrea Bandelli

The experience of the last three years at Laboratorio dell'Immaginario Scientifico, Trieste, with educational projects and network technologies in a science center has brought me to identify four points which represent the shift from the science center as we know it today, to a new structure that will be less and less a science "center," but rather a knowledge lab, almost completely independent from a physical location with its exhibition areas.

The main focus of this article will be the learning experience, targeted to the school groups and in general the younger public (aged 7-18). It is not meant to exclude, however, an extension of this model to the general public and the entertainment aspects as well.

The experiences and projects I will refer to are collaborative projects done over the network. In short, we at LIS developed a series of educational activities on selected topics (air pollution, garbage recycling, drugs, energy), asking the students in several schools from all over Italy and now from all over Europe to work on these subjects, and to use the network to exchange materials, keep in touch, share resources and communicate.

Computer network technology has radically changed the learning experience that a science center can give. If we contrast the new experiences with the experiences of a conventional visit to the science center, the following aspects stand out:

- Broader and long-lasting learning experience;
- Direct and continuous contact with real sources of knowledge and research;
- Higher social experience; and
- Customization of the learning experience.

Broader and long-lasting learning experience

The communication network allows students to exchange ideas, comments, and data in real time, at any time. In addition, the network acts also as a database: it is always possible to easily refer to past messages and data. Every single scientific topic can be seen from different points of view. At the same time, in the school system, different curricula and classes can approach that subject using different tools and depth levels. The communication network makes it possible for small groups to concentrate on specific aspects of the subject, thus going deeply into the topic, without losing sight of the general phenomena, because they are always informed about what their mates are doing. In this way the scientific knowledge becomes a tool for teachers, who can "use" the resources of the electronic science center in a different way every time.

The division of work into small teams makes the experience valuable also from a broader point of view than merely the transmission of contents: coordination between the groups, ways to present data and research results, and communication protocols are important tools that our students learn.

It is important to remember that all this is a continuous process, and not a series of "events" in the scholastic life.

Direct and continuous contact with real sources of knowledge and research

Rather than giving content, we provide ways to reach the content: all of the activities that the students do refer to the original sources of information. Students organize themselves to go to research institutes, contact scientists, organizations and companies, to find out the data essential to their project. Enthusiasm is a strong motivation in these projects. The fact that students can choose their preferred field of activity, and that they can have daily contact with their mates from several different places, are very strong motivations to excel in their project. Likewise, the contact they have with the information sources is continuous; it is not limited to a school visit, but is a self-motivated discovery which in almost all cases is also extremely welcome from the sources' side.

Higher social experience

During these projects, which often last for half a school year, the students get to know each other much better than during traditional school activities. Working closely for several weeks, deciding how to organize the work, and sharing new and exciting experiences outside the school, provide an unparalleled social experience, which cannot be replaced by an occasional group visit to any institution.

Customization of the learning experience

This learning experience is customized for every single class, every teacher and almost every student (at least it is customized for the working teams). Customization is in terms of location (which in this way becomes irrelevant), content level (which can be interactively flexible), and dynamics (time, level of attention, and sub-topics to explore).

Following this model, the physical science center becomes almost unnecessary, since all the students' activities are coordinated and conducted over the network. The electronic science center becomes a sort of knowledge lab, a virtual place which promotes dissemination of scientific culture in a much more direct, flexible and complete way, and provides entertainment and social experiences as well.

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THE DOOM-SHAPED THING IN THE KITCHEN: THE FUTURE OF THE SCIENCE CENTER IN THE 21ST CENTURY

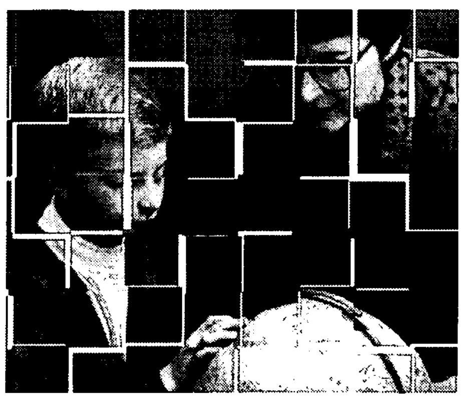
James M. Bradburne

I would first like to set this debate in a broader context by sketching out some starting points for the discussion. There are two key distinctions to keep in mind.

First, the science centre is one member of a family of institutions of informal learning. The family as a whole has a specific identity - not some Platonic ideal of a science centre itself. Within the family there are many members - science museums, museums, and interpretive centres - each a specific response to a specific need. These institutions are in a continuous process of transformation, and such transformations are an essential and unavoidable part of all institutions. Transformation, however, does not mean eradication

Second, an institution is not defined only by its building. An institution is a group of people who structure their joint activities according to a series of commonly articulated goals, usually to serve specific kinds of needs. Thus the Church prays to save our souls, the government exacts taxes to build roads and protect borders, and schools prepare our children for work. The existence of the Church does not require a cathedral, the Government does not demand a City Hall, and the School does not need a classroom. However, for many reasons to be argued below, having a physical site often enhances the effectiveness of the institution - a cathedral enhances appreciation for the Divine, a City Hall legitimises joint decision-making, and the classroom ensures uniform delivery of structured material. At ta recent meeting Cheng Dong Hong spoke about her work in China, where the science centre she directs has no building of its own, but inhabits existing spaces such as research laboratories, school classrooms, and community centres as needed. Nonetheless, in terms of its mission, it is demonstrably an institution of informal learning. What do I mean by an institution of informal learning. Our institutions of informal learning, to quote Jonathan Miller, 'prepare our children to create a world where the life of the mind is a pleasure.' These institutions also are enhanced by having a physical site, and the institution's central activity is often to structure public spaces for informal learning:

- structure: their prime role is interpretation (not collection)
- public spaces: they operate in public realm, open to a variety of users
- informal learning: they do not test, exclude, or pre-model their users.



The proposition being debated is quite extreme, perhaps rhetorically so: is the science center doomed? The argument seems to have two distinct, albeit related parts:

1. New electronic technology is better at meeting some of the explicit educational goals of the science center than is the public interpretive environment; and

2. Since this technology is independent of a public space, the science centre is doomed due to competitive pressures, from domestic computer games, the Internet, and by other, less costly, higher return educational experiences.

Let us look at these arguments in greater detail.

• argument 1 - new media are better at some things

It is argued that certain kinds of informal learning are better supported by new media and new technologies. Certainly exhibitions like *Mind Games* have shown that computer games are an effective way to create what Cziksentmihalyi calls the 'flow' experience. Institutions like the Laboratorio dell'Immaginario Scientifico (Lis) have shown the tremendous potential for creating linked group learning activities via the Internet. Moreover, exhibits like *Hotseat* have shown the limits to the expectation that visitors will debate total strangers face-to-face in an exhibition setting, while Internet forums are a proven means to support sustained interaction.

The above is certainly true, and it would of course be folly for any institution of informal learning to ignore the obvious advantages of new media, and the lessons already learned about the limitations of other media, such as hands-on exhibits. The new media are an indispensable means of fulfilling the mission of creating a social forum, putting science and technology in context, and promoting high-quality learning experiences. Nevertheless the new media are only one amongst many - it is the informal environment itself which is truly multi-media, not what the computer industry calls multi-media.

This said, are there kinds of informal learning experiences that are better supported by a public interpretive environment? Surely there are. Without ignoring the fact that all experiences in the museum are in some ways mediated, and are therefore no more or less 'real' than a computer game, there are experiences - be it of an artefact or a demonstration or making a dam in running water - that cannot be replaced by new media, nor would they even try. The power of a live demonstration cannot be replaced by a talking head on a 17" screen, whatever the inherent interest of the subject. The extraordinary variety of a visit in a public space, where one can read a paper, play a computer game, make a

See "Future," continued on next page

"Future," continued from previous page

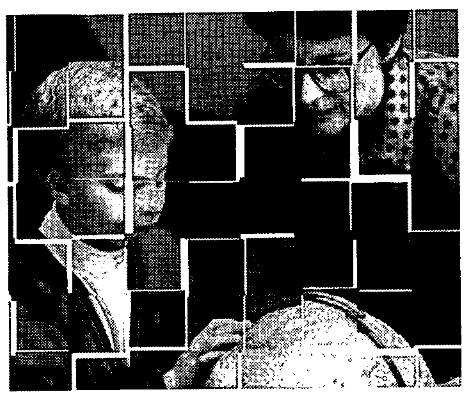
bridge out of blocks, have a coffee, kiss your sweetheart or chat with friends, can never be rivalled by an experience circumscribed by a video screen. Regardless of the social dimension of the Internet, it is difficult to imagine it ever having the emotional quality of real, face-to-face, co-ordinated exploration - the kind found at puzzle tables, water exhibits, and discovery rooms. The necessity of this face-to-face interaction is recognised by the best Internet-based projects (such as Journey North and the programmes of the LIS), which use the technology as only one small part of a series of co-ordinated, social, learning experiences.

• argument 2 - our institutions of informal learning will be replaced by the new media; therefore the science center is doomed

It is argued that, in the first instance, because the new media are better at certain things, this of necessity spells the end of the science center. In effect, the argument runs as follows, using the example of another institution (in fact the only other institution that came readily to mind - institutions are by their nature extraordinarily resilient) doomed by modern technology, albeit some years ago - the public baths. Considered an indispensable part of social life to the Romans, an amenity well into the nineteenth century, the public baths have largely disappeared with the advent of hot and cold running water and private bathrooms. The socialising that was once seen as indispensable to the process of bathing (and still sustains the institution in places such as Japan, Budapest, and perhaps even in Helsinki) was not enough to keep the institution alive under the onslaught of new technology.

The argument seems to run that science centers are in the same position as the Roman baths. Technological change will render them obsolete. Surely the evidence for this is weak. Television did not kill the theatre. Domestic appliances have not eliminated the restaurant. Interactive exhibitions have not killed object-oriented museums. Video has not killed film, nor rendered film-making obsolete.

It is, however, true that the new media have transformed aspects of the older ones. Video has not killed the institution of film-making by Hollywood, although the number of cinemas has declined dramatically. The effect of new technology has been to cause the institutions to respond by integrating and absorbing the technology on the one hand, and transforming themselves on the other. The question we must pose as professionals is, are we film-makers, or are we cinema usherettes? The former still exist in strength, while the latter have been rendered marginal.



This is where the distinction made earlier between the institution, and the building which houses the institution, is key. By responding to and incorporating new media in the science centre, the institution only becomes richer and more effective. It can swallow the new media in a single bite, while offering facilities unavailable at home - in the case of IMPULS, a café, a good restaurant, musical performances, live theatre, a picnic in the sunshine. Because science centers, and more generally the entire family of public institutions of informal learning, can provide experiences that the new media cannot, and can, at the same time, freely adapt and incorporate the new media, the institution is unlikely to falter or fail except as a result of trying to resist the new media - hardly a wise tactic, and one which few museums are proposing. On the contrary, across the full spectrum of museums we see initiatives that take advantage of the new media - CD-ROMs, computer games, interactive databases, and Websites. All of these opportunities serve only to augment the depth and extend the range of existing institutions, making them more flexible and more attractive.

It is argued that the role of the science center is diminished because it will no longer be the only institution that provides informal learning experiences, and by extension, that other institutions will take over the tasks of the museum. An even more provocative argument is that the new media will make institutions of formal learning unnecessary. This argument also appears weak. Surely the museum or the science center has never claimed to be the only institution that supports informal learning. Libraries, research facilities, companies, and governments all actively do so, and have done so long before the advent of the new media. As in the case of the science centre, new media only helps them do it better.

This leaves the question of the building itself, and one of the key questions our institutions of informal learning must face in the coming decades is whether or not massive, capital-intensive building projects are advisable. Would we be well-advised to recommend to fledgling film makers the building of new, 1000-seat cinemas? Or would be better advised to tell them to think hard about the possibilities in made-for-TV video production? A similar question obtains for science centres. Given the vast range of learning opportunities made possible by the new media, the question of where the institution should place its efforts is critical. The real question is not "will the institution survive?," but rather, should we be uncritically promoting largescale building projects under the guise of creating new institutions?

It is argued that the new media means that the science centre no longer needs to be a place at all. Again, this is as true (or false) as it has been before the advent of new media. Institutions such as the PWT in Holland, the Science Alberta Foundation in Canada, and the CAST science centre in China, have shown that you don't need a perma-

See "Future," continued on next page

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nent exhibition space to create informal learning experiences - you can appropriate them. Institutions such as the Laboratorio dell'Imaginario Scientifco and the Davis Science Centre show that you don't have to build an urban mega-project to be a science centre, and that to do so may be to limit your flexibility and effectiveness. Whatever the strategy, however, it always involves public space.

Real physical space is indispensable. Moreover, 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. 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 Internet). 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 space, and the public human exists in a public space.

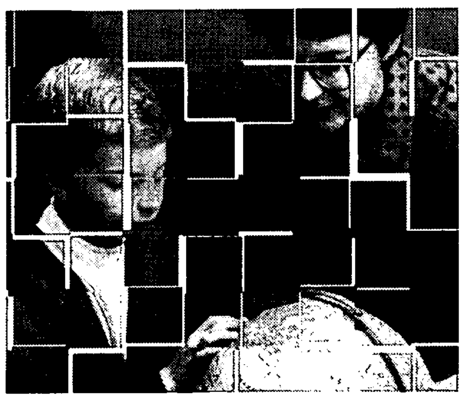
A good illustration of the need for public spaces is the rapid growth of the Internet café. If the computer and the Internet were enough, why an Internet café? People do not go to a restaurant to chat with other diners, but we still go to the restaurant instead of eating at home. Moreover, it is the specificity - the locality - of the place that often has the greatest allure, not the cuisine.

For existing institutions, the new media can open up new opportunities that bring them closer to their missions. Instead of feeling obliged to duplicate experiences found in other centres, they can focus on the specificity of their location, culture, and physical visitors - while creating shared experiences via the Internet. Now more than ever our institutions can "act locally, and think globally."

In closing, let me suggest some possible conclusions to this argument, which ...ame in terms of some of the goals of my own institution, IMPULS, in the words of its director, Joost Douma:

• **a prototype for the 21st century** - the 21st century will see rapid transformation of our society, much of it due to new technology. We must embrace those technologies which genuinely foster the skills the next generation needs to cope with change;

• **high value, not high volume** - our institutions must focus on creating a high value informal learning environment in all respects, and for all its 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, and the Internet for its access to global resources of both information and interaction



• **visitors into users** - our institutions of informal learning must not be satisfied with the casual visit, nor be driven solely by the turnstiles. The museum must draw lessons from the library, as well as the theme park, and provide experiences that satisfy the full range of interests and expectations

• **be a social forum** - the need to be among other people is incontrovertible, and is the prime motivation for the majority of our visitors. We must take advantage of the special character of a public space - and animate it continuously with actors, floor staff, debates, discussions, events, and performances that add to the social experience of the public space

• **think globally, act locally** - the new media 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.

To conclude, it is important to emphasise the fact that the key to the survival of our institutions of informal learning - both as institutions, and as places - is in meeting the needs of a wide variety of users. We know from extensive research into the motivations of users of our institutions that most visitors do not come for high intensity, challenging learning experiences. Rather, they come for social interaction in a public setting. However, our frequent users do come for such learning experiences, and often leave disappointed. The new media allow us to provide high-quality learning experiences for our frequent visitors - our real users.

At the same time, we cannot extrapolate from the success of these media with some of our visitors (fewer than 20% in fact) that there is no need for high quality public space, and activities which exploit and encourage interaction. As with many of the polarities that have dominated the field for decades, the most pernicious being education OR entertainment, the real answer is of course both. It is not a question of new media OR social space, but using both effectively to support the greatest number of users.

As a consequence, our institutions should take the initiative in developing new products and programmes with new media. As specialists in informal learning we are well positioned to take a leading role in creating new approaches to informal learning. We may not be alone in the field, nor should we be, but the institution's future is guaranteed as long as we continue to take the initiative in creating rich informal learning opportunities - inside and outside the institution, in the science centre and on the Internet.

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"Information," continued from front cover

Most Info Tech exhibits are used primarily for the display of information. These exhibits may be classified by their location within a coordinate system having one axis going from passive to interactive and a second axis going from static to dynamic (see Figure 1):

• Passive exhibits require little reaction from the visitor either physically or intellectually.

• Interactive exhibits engage the visitor's reaction and/or intellect.

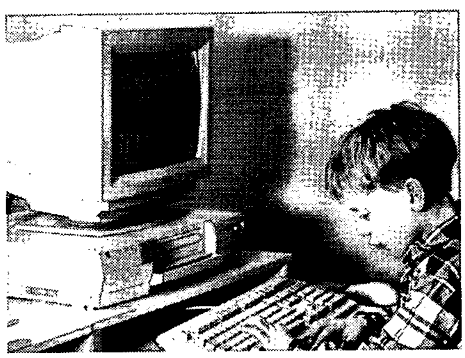
• Information in static exhibits never changes. The information is always presented in the same way at the same time in the program. Static information cannot be created or destroyed.

• Information in dynamic exhibits changes constantly. The information presented at any given time in the program may be affected by many different factors, including visitor choice and chance. Dynamic information is created or destroyed as required.

Databases, Encyclopedias, and Electronic Books

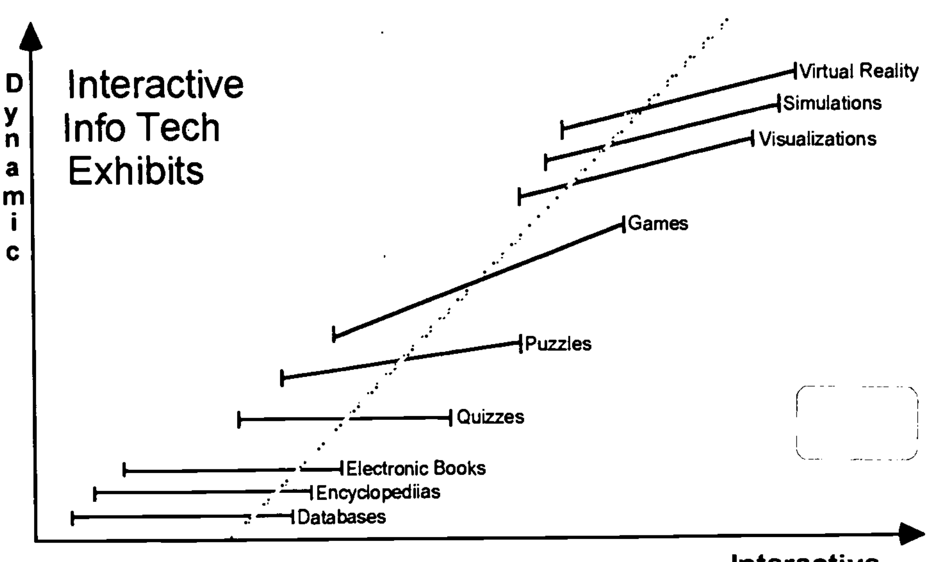
Databases, encyclopedias, and electronic books represent the most passive, static displays of information. The visitor is generally limited to reading text, viewing pictures, listening to speech or other sounds and watching video clips or animations.

Databases are simple collections of static information. The worst of databases fail to engage the visitors' mind or motivate the visitor to explore. The best databases link items of information to form a complex web of connections that invites visitors to discover intriguing and unforeseen relationships among items of information. The *Animal Information* database in the Primate Discovery Center at the San Francisco Zoo is a simple example. It stores information on primates which visitors call forth by touching video screens.



Elaborate databases often grow into encyclopedias. Encyclopedias are more complex, "all-inclusive" collections of information. Encyclopedia articles engage the visitor's intellect more than databases by explaining the meaning of information. However, they also risk overwhelming visitors with too much content. The *Discovery Center Topics* encyclopedia in the Primate Discovery Center at the San Francisco Zoo includes the Animal Information database listed above as well as many other databases. Additional topics include Posture, Conservation, Home Range & Daily Path, Habitat, Distribution, Body Language, Social Behavior, and Vocal Communication.

Figure 1: Interactive "Info Tech" Exhibits Coordinate System



Electronic books are collections of information in the form of stories. Although some electronic books are even less interactive than databases and encyclopedias, they may engage the visitor's intellect by presenting a particular message or point of view. *Primates, DNA, and Mammals* is an interactive laser videodisk exhibit at American Museum of Natural History in New York. Each kiosk tells a non-linear story about evolution. All three kiosks include music, narration, and a central video window surrounded by touch buttons.

Anyone who is contemplating the use of databases, encyclopedias, and electronic books in science museums should take a very close look at the *San Diego Zoo Presents...The Animals* CD-ROM. Although not meant to be used as an exhibit, this product is an excellent example of a combination multimedia database, encyclopedia, and electronic book.

The main menu of *San Diego Zoo Presents...The Animals!* is a three dimensional map of a cartoon zoo. The map represents a topical index to all the information in the program. Areas (topics) include: The Library, The Nursery, Guided Tours, Inside the Zoo, Information Kiosk, Storytime Theater, Kids Corner, Research Center, and the Zoo Gardens. There are also areas for ten different biomes: Tropical Rain Forest, Montane, Tundra, Desert, Tropical Dry Forest, Savanna, Grassland, Temperate Forest, Taiga, and Island.

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The number and flexibility of links between items of information in. *The Animals!* CD-ROM encourages exploration and invites the user to discover new relationships among items of information. For example, from the Library area on the Main Menu Screen the user may begin by selecting the Animals Alphabetical database and jumping to the "home" exhibit of the Snow Leopard. Here they may look at Snow Leopard pictures and listen to Snow Leopard sounds. They may also discover that Snow Leopards inhabit the Montane Biome and decide to jump to additional exhibits about this topic. Or they may use the "Explore A/V Links" icon to look at pictures of other leopards, and become interested in the Clouded Leopard. Jumping to the Clouded Leopard home exhibit, the user might discover that Clouded Leopards inhabit the Tropical Rain Forest Biome, and so decide to use the "Jump To Exhibit" icon to look for other animals inhabiting the same biome. After looking at exhibits about several other animals, the user might end up at the Lowland Gorilla exhibit. Here they may discover the audiovisual link to a Story Screen called "Raising Gordy Gorilla." Jumping to the "home" exhibit of this story will lead the user to the Nursery area of the Main Menu where they may become fascinated with the problems of raising many different kinds of baby animals.

When visitors view animals within a zoo immersion exhibit, natural history dioramas, or in a natural setting, they catch but a glimpse of the true dynamics of nature. We have limited perception because changes often take place too quickly or gradually for us to experience the full texture and cycle of natural change. An interactive multimedia exhibit, *Seeing Time* by Red Hill Studios, combines slow motion and time lapse photography along with animation to reveal the deep and subtle changes in nature. By navigating through a virtual "Time Tower", visitors can view more than 180 timelapse/slow motion video clips and animations that display phenomena occurring outside the realm of human time perception. The clips are organized by time scale and topic. By clicking on various icons, visitors can access information about "What's Going On", manipulate the speed of the phenomena, or make it go backwards or forwards.

Quizzes, Puzzles, and Games

Quizzes, puzzles, and games all contain information in the form of problems and solutions. They occupy the middle ground between passive, static displays of information and interactive, dynamic displays of information. Since they also occupy the middle ground between inexpensive and expensive, they are the most common type of interactive exhibit.

Quizzes contain information expressed as questions and answers. Because they engage visitors' minds in a search for answers to questions, quizzes are generally more interactive than databases. Unfortunately, they are just as static. Visitors are asked to match a pre-existing solution to a problem rather than to manipulate information and discover their own solution. Typical is the *Nova Science Quiz* laser videodisk exhibit produced by the WGBH Educational Foundation for the Boston Museum of Science. Visitors select questions accompanied by pictures clipped from WGBH's "The National Science Test" show. Questions cover a wide range of subjects from interferon to whales, power plants, and trains. Correct answers are rewarded with "bonus information." Incorrect answers "trigger further explanations and fascinating facts."

Puzzles consist of problems and solutions expressed in a more free form and unrestricted format. Like quizzes, puzzles engage the visitors mind in a search for the solutions to problems. Puzzles are much more dynamic than quizzes. They encourage visitors to discover solutions to problems by actively manipulating information. Sometimes random permutations of information will produce the solution to the puzzle. More commonly, a key sequence of manipulations is required. An example of the former type of puzzle is the *Continental Puzzle* from the "Earth Over Time" videodisk produced by the Interactive Videodisk Science Consortium . This puzzle has continents scattered around on the screen, which the visitor can drag together until they form the ancient super continent of Pangaea.

Games are contests among players searching for the solutions to very elaborate problems. Games are generally more interactive than quizzes or puzzles. They usually engage the visitor's reaction and intellect at the same time. Games are also much more dynamic than quizzes or puzzles. The visitor's ability to manipulate information may depend on many complex factors, including random chance. Unfortunately, games run the risk of overwhelming content with contest as visitors become more interested in scoring points and winning the game than in learning facts.

Role playing games and exploration games are two common types. The *Save The Beach* game on the "Earth Over Time" laser videodisk, produced by the Interactive Videodisk Science Consortium, is an example of a role playing game. In this exhibit visitors hear different opinions about how to prevent beach erosion from people living in a shoreline community. After hearing about these viewpoints, visitors can vote on a strategy and see how their choice would have affected the beach and its community.

Dinosaur Safari, produced by the Oregon Museum of Science and Industry, is more of an exploration game. In this exhibit, visitors "travel" to 300 different locations scattered among 5 different Mesozoic time periods. Although the ostensible goal is to capture photographs or video images of hidden dinosaurs, the visitors' primary activity is that of exploration. As they explore different time periods, a

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guide offers information about the locations, time periods, dinosaurs, plants and animals.

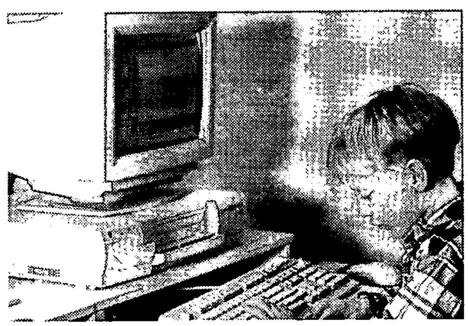
Visualizations, Simulations, and Virtual Reality

Visualizations, simulations, and virtual reality represent the most interactive, dynamic displays of information. These exhibits engage a visitor's constant reaction and/or intellect by continually creating new information. By making this information easy to manipulate, these exhibits may create "controllable worlds" that allow a wide range of experiences.

Visualizations create visual information by manipulating more abstract (usually numerical) data. Because visualizations require visitors to play a very active role in the manipulation of information, they may be more effective learning tools than quizzes, puzzles, or games. However, a very high price is paid for their efficacy. Visualizations may be just as expensive to produce as simulations or virtual reality, but they are not nearly as engrossing. The best visualizations are those which demand relatively little of the visitor's time and reward their efforts by dramatically demonstrating relationships among otherwise abstract data. For example, Mandelbrot Set visualizations allow visitors to see the relationships between certain numbers emerge as colorful shapes produced by magnifying different regions of the Mandelbrot set.

Anyone who is interested in discovering the incredible power and versatility of visualization techniques should take a good look at CD-ROMs developed by the U. S. Geological Survey, National Oceanic and Atmospheric Administration, and the National Aeronautics and Space Administration. These discs contains thousands of images and related educational software for classroom use. And what imagery (!): Landsat imagery of Yellowstone National Park, satellite imagery of Antarctica, visualization programs of planets and moons (from NASA's Voyager files), 3-D images of ocean floor (from sonograph data), and plots and analyses of the spectra of comets. Supporting software, for example, allows graphing of Pacific Ocean salinity, temperature data, retrieval of stratospheric ozone data, and the display and analysis of seismograms.

Simulations create new information by repeatedly re-evaluating mathematical models of "real world" objects and events. The distinction between simulations and visualizations may be blurred when simulations use visualization to communicate their results. The role of pure visualization exhibits is to help the visitor discover concrete relationships among data. The visitor manipulates data. The role of pure



simulation exhibits is to help the visitor develop an intuitive feel for a phenomenon. The visitor manipulates a model. Simulation and visualization are often combined to make games and virtual worlds.

The *Salt Marsh Gallery Kiosk* at the Maritime Center of Norwalk, Connecticut is a very simple simulation of a marsh based upon a model of the interrelationships among biotic, marine, and animal life. Visitors adjust the population of different creatures (mosquitoes, redwing blackbirds, silversides, human fishermen) and see how it effects the marsh.

The various Sim programs from Maxis Software, such as *Sim Ant,* are a combination of a simulation and an exploration game. Players explore terrain by controlling the movement of a single ant as it forages for food, lays down scent trails, battles ants from other colonies and tries to avoid predation from spiders and other insects. Players manipulate the rate of egg laying, nest building, foraging, and mating. Their goal is to build the greatest number of new colonies while keeping enemy ants from doing the same. To accomplish this goal, players must develop a "feel" for real ant behavior.

Like visualizations and simulations, virtual reality exhibits create information by manipulating data and/or mathematical models. Unlike visualizations and simulations, virtual reality exhibits immerse visitors in the exploration of an imaginary space. A broad range of immersion is possible depending on available technology.

Virtual Travel (Desktop VR) exhibits are the least immersive. These exhibits use conventional devices for input (touch screens, trackballs, etc.) and the screen of a microcomputer for output.

The *Mars Navigator* laser videodisk from Volotta Interactive Video is a typical Virtual Travel (Desktop VR) exhibit. It uses a Jet Propulsion Laboratory terrain database derived from the Viking missions to Mars to create a 3-D computer animation of a flight over the red planet. Visitors can choose paths they want to fly on Mars, stop the flight, go in reverse, and access an interactive map and information browser. With Dolby Surround sound "visitors can hear the canyon walls of Valles Marineris rushing past, feel the sound of Pavonis Mons as they circle it, and almost be jolted out of their seats as they bounce off the ridges in Ophir Chasm."

The *Virtual Navigator,* developed by the Center of Science and Industry (Columbus, OH), enables participants to take a journey through a surreal landscape and investigate an architect's futuristic vision. High-resolution video, coupled with a 3-D input device helps visitors attain a feeling of control and manipulation.

Another interesting example of a Virtual Travel (Desktop VR) exhibit is the *Virtual Reality Chair* at the Computer Museum in Boston, MA. Museum visitors sit in a chair built on a turntable and travel through a virtual landscape. Visitors may turn right and left by moving the chair in either direction. On

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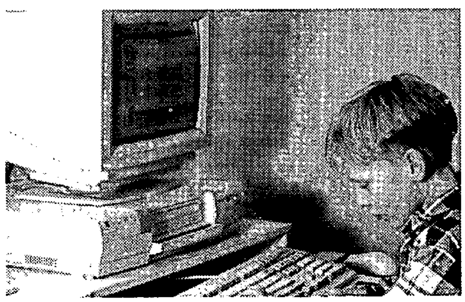
ing the chair in either direction. On the sides of the monitor are handles which, when turned forwards and backwards, allow the user to travel in the desired direction. The chair world consists of an imaginary landscape complete with virtual mountains, a virtual house, and a virtual dog that barks if you get too close.

Mirror World (Camera VR) exhibits are much more immersive than Virtual Travel exhibits. These exhibits use video cameras for input and video walls or large video screens for output. Vivid Effects' *Mandala System* is a common component in many Mirror World (Camera VR) exhibits. The *Mandala System* allows users to step into and control television worlds, live, without physically touching anything. Viewing your own true video image mirrored on a television in front of you, the interaction occurs when your image comes into contact with graphics that surround you on the TV screen, allowing you to control and manipulate animation, sound effects, and external devices (such as robotics) all in real time. Mandala was used to represent the Transporter Room in OMSI's *Star Trek: Federation Science* exhibition. Visitors could "beam down" as an "Away Team" member to another planet. The Mandala System has also been used for sporting exhibits, telepresence, musical instruments, painting, and adventure games.

Virtual Hoops at the Liberty Science Center in Jersey City, NJ is another typical Mirror World (Camera VR) exhibit. The visitor stands before a video wall and is photographed by a video camera that places their image in a computer generated basketball court projected in real time onto a very large video screen. Virtual players are inserted in the basketball court and are able to dribble and shoot virtual baskets. They compete against a virtual opponent who can block, shoot and steal the ball. A similar exhibit, Jump Shot, at the Franklin Institute Science Museum in Philadelphia, PA is the successor to Virtual Hoops.

Virtual World (Headgear VR) exhibits ...s immersive as present technology permits. They use a variety of exotic devices (data gloves, etc.) for input and head mounted displays for output . Walt Disney's *Aladdin* at the Orlando Epcot Center is the ultimate Virtual World (Headgear VR) exhibit. Visitors board one of the exhibit's four VR flight stations and fly through the town of Agrabah on a magic carpet in search of Aladdin's lamp. They interact with computer-generated scenes by grasping the edge of the magic carpet, while viewing the experience on miniature wide-angle television screens in head mounted displays. Visitors are hosted by a real-time computer version of Iago, the classic Disney character from the *Aladdin* movie. Iago exhibits more



than one hundred movements, such as winking, laughing, and crying.

Another immersive virtual experience is the *Loch Ness Monster* virtual reality sub at the Nauticus Maritime Museum. Six people at a time board the small sub, don 3-D glasses, and take one of six duty stations. The interior looks like a small sub; participants look outward through a large underwater virtual window (a move screen). All work together to use robotic arms, periscopes, and a navigation computer to save the eggs of the Loch Ness monster.

The *Networked VR Experience* at the Computer Museum in Boston, MA is an example of a networked Virtual World (Headgear VR) exhibit. Museum visitors work in pairs to build a virtual house in cyberspace. Each visitor is able to don a head mounted display and with a joystick enter a design area to construct a house with walls, windows, ceiling, and a roof. Once the house was completed, visitors were able to walk in and around their creation.

Another Virtual World (Headgear VR) exhibit at the Computer Museum in Boston, MA is *Virtual Adventure: Exploring a Human Cell*. Visitors wear a head mounted device and use a hand tracker to enter a virtual human cell magnified a million times. Participants manipulate cell components, including six foot neurons and various cellular organelles. When visitors place the correct organelles in the proper position in the cell, they are rewarded by seeing an animation of the cell in action.

Part of the *IMAGING: The Tools of Science* exhibit at the Chicago Museum of Science and Industry is a Virtual World (Headgear VR) activity in which a team of three people simultaneously join in a cyberspace journey through a cityscape, a canyon, and an electronic circuit. The activity uses a Fake Space (Menlo Park, CA) BOOM for viewing and navigating. Unlike a typical head mounted display, which is worn like a scuba mask, the BOOM is a free-standing binocular display mounted on an articulated arm. BOOM users merely grasp its side handles, peer through the optical display, and by moving the BOOM around can see any part of that particular virtual landscape. One person navigates through the landscape, while two other people work at manipulating each virtual environment the BOOM's viewer passes through.

There is another genre of virtual experiences, which might be called experiential theater. These shows, which require no headgear and typically combine the experiences of viewing a high-quality 3-D film with motion, are becoming commonplace at theme parks such as Disneyworld and Universal Studios. Examples include the *Star Wars Simulator Ride* at MGM/Disneyworld and *Journey to Jupiter Simulator Ride* at the Huntsville Space and Rocket Center. Star Wars provides visitors in a small ride cabin with a jerking, careening ride through space, incorporating *Star Wars* characters. In a 7-minute voyage in a 30-person platform-based simulator, *Journey to Jupiter* features convincing launch sequences, a quick pass by Jupiter, an evasive maneuver to dodge an asteroid, and return to earth.

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These immersion-experiences are typically introduced through a "pre-show" or exhibit area, which introduces characters or concepts related to the shows or sets up the journey's storyline.

The Cincinnati Museum Center and Iwerks Technologies have developed *Dino Island,* which takes visitors to a remote, recently formed, smoke-shrouded island where they discover volcanic canyons, rivers of lava, and prehistoric vegetation. They also find living, breathing dinosaurs. Motion seats use hydraulic technology which provides the rider with the feel of a roller coaster ride. Visitors do not, however, influence the course of the journey; the route is "pre-programmed."

Simulator rides are extremely popular with visitors at theme parks. The critical element of the rides is the simulation of motion in combination with high-quality images (and sometimes with other special effects). Visitors have little or no control over the journeys; the experiences are engrossing, but passive. Educational content (where there is some) is minimal. Simulator rides are very expensive and often labor intensive, requiring staff to assist and orient visitors. A small proportion of visitors suffer nausea from the motion. Some young visitors may also be frightened.

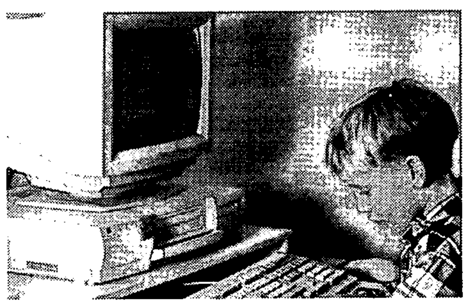
There are two VR auditorium presentations which show great potential for the entertainment market. CAVEs (Computer Activated Virtual Environment), which are now used primarily for research, allow up to 10 people wearing 3-D glasses in a specially designed theater to share a common virtual experience. HMD theater, under development by Straylight (Warren, NJ), may allow up to 30 people wearing headgear to enter a virtual environment.

What Research Says About Learning from Multimedia

The use of computer stations and multi-media in science museums, zoos, and similar institutions is now commonplace. As Barbara Flagg (1991) states in her brief review of visitor research, visitors can see video and animation, hear sound effects, and manipulate the system, but the experience is still, in most cases, viewed on a monitor. Virtual reality is being used more frequently by informal science institutions, but commentators on the VR industry state that VR is at about the same stage now as personal computers were in the late 1970's.

Flagg's summary shows that:

- Interactive units increase the average visit duration.
- Although all age groups use interactive units, greater proportions of younger visitors seem to use the systems than accompanying adults.



- Computer stations are more often used by groups than by individual users, despite the fact that the systems are intended for individual use.
- Computer stations that are part of a larger exhibition tend to be used longer than isolated or stand-alone units.
- Most visitors use computer stations for a relatively short time, ranging from one to several minutes in high traffic areas to ten minutes or more, when the computer stations are in enclosed spaces.
- Formative research has been very important in developing "user-friendly" applications.
- Visitor factual knowledge has been shown to increase after using computer interactives.

In a recent study of the effectiveness of virtual reality as an effective teaching tool, the Computer Museum (Gay and Greschler, 1994) compared how well three groups of users, aged from 5 to 50, learned about cells (the *Exploring a Human Cell* exhibit described earlier on page 11) contrasting groups viewing a videotape presentation with other groups interacting with a virtual world displayed on a computer monitor, or a completely immersive virtual world seen through a head-mounted display. The immersive virtual world seemed to pique the interest of users more than the other experiences. They also more accurately remembered names and functions of cell components, although none of the groups did well.

Science museums face several issues concerning how to incorporate high-tech, from more conventional computer stations to virtual reality and simulator rides, into exhibitions and programs:

- How can high-tech be used appropriately to help science museums achieve their missions? How does high tech "fit in"?
- How can high-tech be used as a means for attracting large audiences?
- How can science museums compete with private industry in offering high-tech experiences which match those provided by Disney, SEGA, and other large corporations which can invest millions in a single game or experience?

The lure of high-tech is strong, but it remains to be seen if science museums can compete with the entertainment industry in presenting high-tech experiences which draw large audiences (over and above regular science museum visitors) and are still cost-effective. There is no doubt that some science museums have seen great success in drawing audiences with VR-based experiences. The *Virtual Hoops* exhibit by the Liberty Science Center and *Liquid Vision* by the Center of Science and Industry (Columbus, OH), have drawn large audiences. These exhibits, however, are primarily entertainment (e.g., visitors shoot baskets or simply try out VR headgear; there is no exhibit content).

Design and Cost Considerations for Interactive Multimedia

Museum environments have some inherent limitations that must be taken

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into consideration designing computer stations or other interactive multimedia. People usually visit museums or zoos in groups. Visitor attention to particular exhibits or animals is usually brief, from a few seconds to several minutes. Here are some design issues to consider when placing multimedia in a museum or zoo setting, as discussed by Mintz (1990), Krakauer, Russell, and West (1994), and others:

1. Context: Computer interactives exist within a physical context — a dinosaur exhibit, an outdoor animal exhibit, an interactive unit on physical science. The computer interactive can complement the adjacent exhibit, whether this involves providing additional information on a species or environmental context. Natural history museum exhibits may present special environments. Computer interactives should be carefully placed so that they do not intrude on the "natural" experience. These interactives should also be effectively placed so that visitors will take advantage of them.

Virtual reality experiences, such as simulator rides, often require a context in themselves. Most simulator rides take up considerable space and often have a queuing and staging area which prepares participants for the ride. High ceilings, traffic flow, motion sickness, and other considerations are important in planning for such experiences.

2. Content: Visitors are usually attracted to interactive exhibits because the experience is attractive and inviting. Information-heavy, slow presentations will discourage visitors, who will probably only stay a short time. At the same time, science museums should consider the purpose of using a computer interactive or other "high-tech" presentation. What is the "message"? Are computer interactives or virtual reality the most appropriate means for engaging visitors and introducing the desired messages?

3. User interface: Visitors have little patience for interactives that don't seem to work or that take a long time ...re out." User interfaces should make it very easy for visitors to "get into" the activity within a short amount of time. If screens have confusing instructions or are too complex, visitors will likely become discouraged. Likewise, if visitors are unfamiliar with how to use a trackball or other parts of the apparatus, they will also become discouraged. Interfaces, such as joysticks, should also be very durable and able to stand up to rough manipulation by thousands of visitors. VR headgear can be uncomfortable. Some visitors may suffer from nausea or anxiety in simulator rides. Formative evaluation is a very important part of exhibit development. The results can help fine-tune exhibit content and user inter-

faces, to assure that most visitors can operate the exhibit and achieve some level of awareness or understanding as a result.

4. Pattern of interaction/traffic flow: Since most visitors have relatively brief experiences with exhibits, computer interactives should also be designed to enable a visitor to have "success" after a brief experience. Interactive computer stations in primary exhibit areas which have high traffic should provide brief experiences. If most visitors are expected to participate in a high-tech experience or use a high-tech device in an exhibition, the capacity of the system is an important consideration. Visitors can become easily frustrated if they must wait for long periods to gain access. Extended experiences can be made available in resource centers.

5. Cost: A final and important issue to consider is that of cost. Although computer hardware, VR platforms, and other high-tech equipment continues to come down in cost, the investment in producing high-quality CD-ROMs, simulator rides, and virtual reality experiences, is still extremely high. At the same time, consumers can now purchase CD-ROMs and simulations for their home computers at a relatively low cost.

It is difficult to provide useful cost estimates for high-tech experiences, without knowing the particulars of the potential experience under consideration. For example, the production of a CD-ROM includes the user interface, content and script development, programming, and production, including the development of any static or moving images required. Thus, development of a CD-ROM, at the low end, can begin at a few thousand dollars, but can go to well over a million dollars for a high-profile disk. This expense may be dwarfed by the sales figures for some of the most popular CD-ROMs (e.g., *MYST*, Disney's *Aladdin*), which approach $50 million. The hardware for a single CD-ROM workstation in a museum environment will likely cost $10,000+, when cabinetry, graphics, and aesthetics are added to the hardware costs. Single VR player stations average between $30,000 and $75,000 a unit.

The production of the video and effects for a high-quality simulator ride may cost hundreds of thousands of dollars. The capital costs of installing a simulator experience with reasonable through-put (i.e., 500+ daily users) will likely range from $1-$3 million after production costs.

Conclusions

The question of how interactive computer exhibits could be used in science museums does not answer the question of how interactive computer exhibits should be used. The answer to this question depends on factors unique to each particular institution. However, some general guidelines may be obtained by referring to Figure 1. The dotted line sloping at a 45 degree angle to the origin of the coordinate system represents the average cost of using interactive computer technology (assuming interactive costs X dynamic costs). Exhibits which fall to the left of this line have a good cost to technolo-

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gy ratio. Thus, databases, encyclopedias, and electronic books squeeze the most value out of relatively inexpensive computer exhibit technology. Unfortunately, their passivity and static presentation of information may make them unappealing to visitors. Design and production of the exhibit is the critical factor. Good designs and efficient production will overcome the problems of passivity and static information. Bad designs and inefficient production will only magnify them.

Quizzes, puzzles, and games offer a balance between static and dynamic, passive and interactive. They have a median cost to technology ratio, but represent the lowest cost exhibits which the greatest number of visitors will find appealing. This makes them the best investment of exhibit money and consequently, the most common type of exhibit.

Visualization, simulations, and virtual reality are more dynamic and interactive than quizzes, puzzles, and games, but at a disproportionately high price. Their poor cost to technology ratio reflects the relatively high cost of their production and display technology. Particularly in the case of virtual reality, the technology is very immature. Production and display costs rapidly escalate with small increments of interactivity. Again, design and production are critical. Good designs may justify the excessive cost of these types of exhibits. Bad designs or uncertain production techniques will only squander large sums of money. Many museum visitors will be used to high quality hardware and high production values on CD-ROMs and other high-tech applications.

When developing interactive multimedia or other "high tech" experiences for visitors, science museums should keep basic design considerations in mind. Experiences should be designed to provide users easy access, to be brief, and to have the potential to accommodate multiple users. Finally, the technology or medium should be appropriate for the message. When "[illegible]-tech" works, such as flip labels, they should be used. "High-tech" applications are more expensive. Designers should not be seduced by the technology.

As new information technologies are being rapidly developed, a fundamental issue faces the field. How should science museums make effective use of Info Tech exhibits, when more and more people can have virtual reality experiences, play group interactive computer games, and access other sophisticated applications at home? While science museums are becoming more "high-tech", so is the rest of the world.

Consider, for example, that at the local sports bar, you may find four players with headgear and joysticks jerking their bodies around as they play Dactyl Nightmare, a game where players try to shoot the other players and avoid monsters controlled by competitors. On the Internet, you may play group games. At home, you may play VR games by SEGA or other companies, using inexpensive headgear and equipment. At the same time, nearly all personal computers on the market now include a CD-ROM player. There are now several thousand CD-ROM titles on the market, with new titles appearing each week. Many of these titles are presented as educational and many deliver on this promise. The Internet, which has revolutionized information dissemination, is now accessible to millions of users, who can dissect frogs, watch videos of DNA unraveling, or communicate with a virtual community of learners with the same interests. Schools, likewise, are rapidly embracing the use of the Internet.

Science museums will be continually challenged to stay current to maintain a competitive edge and provide the quality visitors expect. This will be difficult, when visitors may find similar activities on the Internet or in the classroom. The future of science museums will probably not be made in Info Tech exhibits. As we said in the beginning, visitors are attracted to museums so they can experience real objects, phenomenon, and living things. It is unlikely these experiences will ever be replaced by anything else, despite Star Trek's Holodeck.

But visitors must still choose to come to science museums, since many other choices are available, at home and outside. Science museums, zoos, and other informal science institutions must continue to improve the quality of all visitor experiences, using Info Tech exhibits to complement experiences with real objects, phenomenon, and living things.

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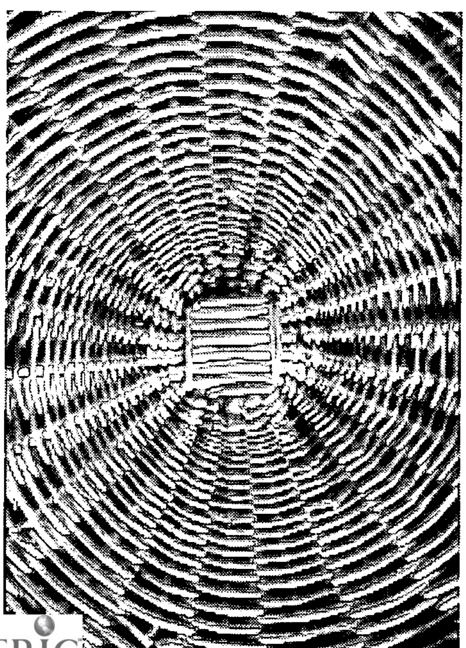
SCIENCE CITY INITIATIVE IN ITALY

With a conscious bow to influence of the Exploratorium, the Deutsches Museum in Munich and La Villette in Paris, the Living Science Museum opened in Naples, Italy, in October.

This interactive museum is the centerpiece of a 65,000 square meter science complex occupying old chemical and steel works on the Bay of Naples. The project ultimately will cost in excess of $90 million and includes, in addition to the museum, a host of "incubator" facilities for developing high-tech and communications companies. Organizers expect this "City of Science" to "act as a motor to drive a far-reaching industrial transformation" in economically-weak southern Italy, according to physicist Vittorio Silvestrini. He is the director of the Naples-based Institute for the Promotion of Physical Culture.

The museum is state-of-the-art. It includes a planetarium with a moving-parts solar system, a geology exhibit on the local Vesuvius volcano, a space ship that transports visitors inside a giant human intestine, and a "science gym" where people can "work out" with trainers, doing environmental measurements or exercises that illustrate principles of physics and math.

- Science, 1 November 1996



The Plan

In the beginning there was The Plan,
and then came the assumptions.

And the assumptions were without form, and The Plan was
completely without substance,
and the darkness was upon the face of the Staff.

And they spoke among themselves, saying,
"It is a crock of ____ and it stinks!"

And the Staff went unto their Supervisors, saying,
"It is a pail of dung and none may abide the odor thereof."

And the Supervisors went unto their Managers, saying,
"It is a container of excrement and it is very strong,
such that none may abide by it."

And the Managers went to their Division Managers, saying,
"It is a vessel of fertilizer and none may abide its strength."

And the Division Managers went unto their Deputy Directors, saying,
"It contains that which aids plant growth and it is very strong."

And the Deputy Directors went unto the Executive Director, saying,
"It promotes growth and is very powerful."

And the Executive Director went unto the Board, saying,
"The new Plan will actively promote the growth
and efficiency of this organization!"

And the Board looked upon The Plan and saw that it was good.

And The Plan became policy!

This is how ____ happens.

SCIENCE CENTRES AND MUSEUMS IN THE ELECTRONIC AGE: *ARE WE DOOMED?*

Roland Jackson

I find myself in an interesting position on this debate. I am fascinated by the potential of electronic media, and have initiated a number of projects within the Science Museum to experiment with some of the possibilities-especially with educational groups. I think the new media have much to offer us, but I do not believe for one minute that they threaten the existence of science centers and museums. We are not doomed at all, but rather we have the ability to extend our impact enormously.

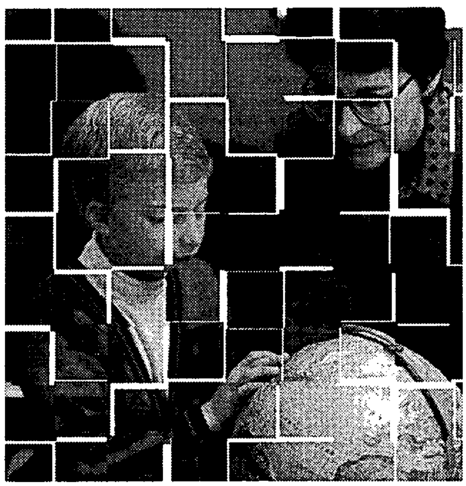
Why do I not think we are doomed?

My reasons are based on our understanding of how people choose leisure activities, how people learn, and the variety of ways, beyond the screen, through which we can present experiences to people that are both enjoyable and educational.

There is an enormous range of experiences you can have in a place like the Science Museum. They include: direct encounters with things people have made (from mummified cats to the Apollo 10 capsule); experience of a wide range of physical phenomena through interactive exhibits; drama characters in context; science shows with lively audience participation; and, of course, camping overnight in the museum. I do not believe that on-screen experiences can replace these real ones. The basic reasons are very simple: you cannot beat the thrill of seeing the real thing; you cannot beat the real physical experience of a scientific or technological phenomenon; and you cannot (unless you are a strange personality type) beat the experience of real social interaction-it is not the same over the Internet, nor is an Internet cafe comparable in function and enviroment to a cafe in a science centre. Indeed, as was pointed out by a member of the audience during the te, the term 'multimedia' is a con by the IT business. It is science centers and museums that are the real multimedia environments. A screen with text, images and a bit of sound hardly competes.

Current directions, and what electronic media can do

Remote networking allows two distinct types of activity relevant to people who might visit science centers and museums- (1) access to vast amounts of information (e.g. on-line multi-media exhibitions) and (2) real-time communication with others (e.g. participation in on-line events, projects and distance education sessions). Given projected increases in bandwidth and speed of access, in interactivity (through the new languages such as Java) and in 3D



visualisation, there is no doubt that those who can afford the premium services will have some fascinating and often educational experience. We must take advantage of these opportunities, and not just for marketing purposes, to present our subject matter in interesting ways on-line and to organize on-line events that have links with our physical reality. I believe that if we do this well we are likely to attract more rather than less visitors to our actual buildings. The interest created in the University of California Museum of Palaeontology through its Web presence is an example of just that. But we will have to do it well!

Limits to the potential of electronic media

I have already indicated two major factors that place limits to the potential of electronic media (and I won't even mention accessibility, speed, bandwidth and cost, all of which are big problems). They are people's reasons for choosing leisure activities, and the means by which people learn.

Marilyn Hood, in her extensive analysis of why people do and do not visit museums (1989), identifies six major factors, which are of differing importance to the three major audience segments: frequent visitors, occasional visitors and non-visitors. The frequent visitors are already fully 'socialized' into museum-going. Provided that we keep the environment changing, reflecting their need to have new experiences, do something worthwhile in leisure time and have an opportunity to learn, we should be able to keep this already committed audience. It is the infrequent visitors who are likely to be most easily attracted elsewhere, and I imagine we would like to encourage current non-visitors to visit as well. Here the outlook is particularly positive. Both these groups of people like active participation, entertainment and social interaction. It is that desire for a shared physical and social experience, sought particularly by family groups, that cannot effectively be met on-screen through a remote network. Electronic media can certainly provide aspects of entertainment but the participation, though active in some senses, is often curiously solitary and even anti-social. It caters to a minority (generally male) of visitors.

Now to the question of learning styles. Theories of learning essentially deal with how people make sense of the world. In that context they are relevant to all our visitors or potential visitors, regardless of whether or not the visitors have come with the specific intention of learning something. (Although I would argue that almost everyone comes to a science center or museum rather than, for example, a theme park, because they do enjoy finding things out about the physical world). No one theorist has a monopoly on how people learn, and it is sensible for those of us constructing interesting and

See "Doomed?," continued next page

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broadly educational experiences, as we do in science centers and museums, to take account of the range of theories and provide means of access for the range of types of learners identified by the various researchers. The approach implicit, and often explicit, in science centers and museums around the world at present (and indeed in places of formal education) builds on many theorists-Piaget, Bruner, Vygotsky, Gardner, to name a few. Out of these one can identify the need for concrete experience, the role of language and the need for social interaction, and the variety of different cognitive preferences and learning styles that visitors bring with them. As a consequence, most science centers and museums deliberately provide a diverse environment: static displays, aural and video presentations, hands-on exhibits, drama, shows, workshops, lectures and the use of poetry, music and art. In other words, they use multiple mixed media and multiple mixed modes of delivery. Everyone can find an entry point somewhere. The on-screen, on-line environment is simply not diverse enough. It will appeal to some visitors at some times, but never replace the diversity of real, social, mixed media experiences.

Let me finish with some words from Csikszentmihalyi (1995), who applies the concept of the 'flow' experience to explaining how to provide the intrinsic motivation that makes visitors want to participate and learn. He says that "in one respect, museums seem to have a distinct advantage over solitary media-induced experiences. They provide information in a public space where there is the potential to develop the integrative dimension of personal growth. We learn about connectedness through rituals-such as ceremonies or rock concerts-and whenever we are exposed to an event that is shared with others that feeling of connectedness is strengthened. In modern society, however, there are fewer and fewer venues to experience such shared events. Perhaps one of the major underdeveloped functions of museums is to provide opportunities for individually ingful experiences that also connect with the experiences of others." Ultimately it comes down to the emotional and intellectual need for most people to share experiences of concrete things and physical phenomena with other people in a stimulating yet comfortable social environment.

Reality lives, on-screen experiences are a fascinating supplement, and we are certainly not doomed!

Hood, M.G. (1989) in Museum Visits and Activities for Family Life Enrichment, ed. B.H. Butler and M.B. Sussman, Howarth Press.

Csikszentmihalyi, M. and Hermanson, K. (1995) Intrinsic Motivation in Museums: Why does one want to learn? in Public Institutions for Personal Learning, ed. J.H. Falk and L.D. Dierking, AAM, Washington.

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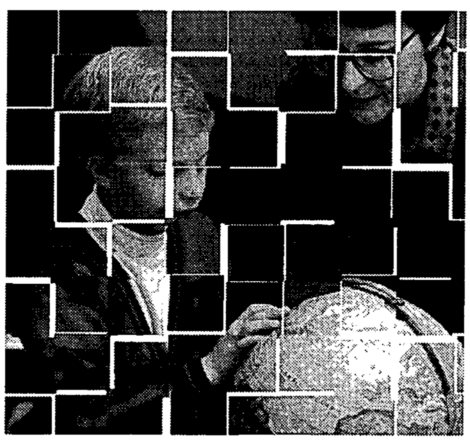


NATIONAL ENGINEERS WEEK IS FEBRUARY 16-22, 1997

Once again, National Engineers Week calls attention to the conjunction of math, science and engineering. Engineers nationwide will carry out high-visibility projects such as "engineering day" at museums, libraries and schools, tours of local engineering projects, and visits to classrooms to provide hands-on activities and discuss engineering careers. The Future City Competition, for 7th and 8th graders, will culminate with its national finals in Washington, DC. In Engineering Goes Public, engineers and engineering students sponsor special exhibits and activities at shopping malls, science centers and libraries. In 1996, more that 35,000 volunteer engineers participated in the outreach efforts.

Information: National Engineers Week Headquarters, 1420 King Street, Alexandria, VA 22314; (703) 684-2852; e-mail eweek@nspe.org. Free planning kits are available from National Engineers Week, P.O. Box 1020, Sewickley, PA 15143; (412) 741-1393; fax (412) 741-0609.

INDIAN ORGANIZATION RECOGNIZED FOR PUBLIC SCIENCE EFFORTS

Sweden's Right Livelihood Foundation has honored an Indian organization that has adopted a pioneering approach to public understanding of science in the southern state of Kerala. One of the three recipients of the 1996 Right Livelihood Award — sometimes described as the 'alternative Nobel Prize' — is the Kerala Sastra Sahithya Parishat (KSSP), the people's science movement of Kerala.

The KSSP communicates by simultaneously emphasizing its impact on society. KSSP now has 60,000 members, including 10,000 teachers. It is widely considered to have contributed to Kerala's high levels of adult literacy - 91 per cent - and life expectancy - 71 years - compared with the Indian average of 52 per cent and 60 years respectively.

- Nature, vol. 383, 17 October 1996, p. 568.

THE NEW INFORMAL SCIENCE EDUCATION

Drew Ann Wake

In the mid-seventies, the locus of informal science education changed from science museums toward a new type of institution, the science centre. These new institutions were characterized by a dependence on interactive exhibits, rather than a collection of objects.

Those of us who were just starting into the field at that time remember many vociferous arguments between museum and science center professionals. Museum specialists argued that interactive exhibits were merely a form of entertainment, while science center professionals insisted that people learned about science more effectively through exploration and experimentation, than through the more passive learning techniques which prevailed in conventional museums.

While the argument raged, the new science center institutions proved to be extremely popular. Although science and natural history museums did not disappear, they did find that a portion of their traditional audience was drawn to interactive science centres. And many museums found they had to adopt interactive exhibits - even full galleries of interactive exhibits - in order to compete successfully.

I suggest that we are entering another period of transition in the history of informal science education, one which is characterized by a new technological revolution: the computer network. I believe that this medium will have a serious effect on the attendance at science museums and science centers over the next two decades. And while I do not think that science museums and science centers will disappear, I fear that they will be marginalized as institutions of informal science education. There are, I believe, three reasons for this.

1. The Quality of the Interactive Experience. Just as science center professionals once argued that hands-on exhibits offered a more stimulating learning environment, so I argue that a carefully-planned computer experience enables visitors to participate in more demanding intellectual activities than do many hands-on exhibits. Many (though by no means all) hands-on exhibits aim to help visitors understand a single scientific phenomenon. Computers, on the other hand, enable us to build multi-faceted, problem-solving experiences. Last year we built *Eo: A Game of Animal Survival*, which places players in the "shoes" of a Permian reptile. Players must survive for a year - while confronting four predators, drought, and a scarcity of food and water.

When we designed the game, we wondered if players would find the level of interactivity too high and if they could concentrate on so many things happening at the same time. In fact, we have found that visitors are not only able, but are enthusiastic in their involvement. This game was placed in a gallery that also contained dioramas and hands-on exhibits; the computer game has proved to be by far the most popular activity in the gallery. A year after the opening, the client has only two complaints: the line-up at the computers is too long, and the upholstery is wearing off the seats.

This raises the question: what would happen if our visitors could find this kind of educational experience without going to a science museum to get it?

2. Competition from Scientific Institutions. Although there are some notable examples, as a general rule few scientific research institutions have developed their own hands-on science centers. The process of producing hands-on exhibits and the high volume of visitors required to make ends meet necessitates a dedicated building and trained staff.

In the past, our (educators) role as the intermediaries between science and the public has been secure. Today, however, most scientific institutions are finding it valuable to be in immediate electronic contact with the world. In recent years, they have hired staff responsible for creating new electronic materials for both the scientific community and the public. Initially, these materials had a hokey, amateur home page feel. But over the last year scientific institutions have been producing a far more sophisticated product.

As an example, I will cite the work we are doing with a new federal government laboratory in Western Canada. The challenge was to communicate agricultural research in terms that are comprehensible and interesting to the public. This is no easy task, given that most of the work is highly complex - and invisible.

Working with the scientific staff, we developed a computer game that renders three research laboratories on the screen in 3-D. The scientists appear in the game in full-screen video, demonstrating their work and challenging the players with quizzes that use their new-found knowledge. The ease with which the scientists have learned to develop computer games suggests that our unique role as intermediaries between scientists and the public is not secure.

3. Competition for the Family Budget. We are living in a time of reduced income and reduced expectations. It is estimated that in the last ten years, disposable income for the typical North American family has dropped by 15%. So it is not surprising that two of our primary audiences, schools and middle-class families, are having to make difficult choices. Will they choose to send their children to science centers several times a yea:, or will they invest in computer equipment for the home?

The statistics suggest that more and more families are opting for the electronic superhighway. While science center attendance seems to be falling, the number of subscriptions to electronic networks is increasing exponentially. Why is this?

The computer is a flexible tool. Unlike the science center, it is open twenty-four hours a day. There is no need to pay for transportation, or parking, or

See "New," continued on next page

"New," continued from previous page

those appalling Big Macs. The computer has many uses: for research, education and entertainment. Whereas the science center makes an investment in exhibits that remain on the floor for months or years, computer networks provide visitors with new materials every day.

In my home town today, it costs a family with three children $60.00 a year to buy a membership to the local science centre. That same check buys access to computer services for an entire year. Which would your family choose?

To conclude, I think that science centers are facing a growing challenge from the new electronic networks. This does not mean that science centers are doomed to extinction - they may putter on for generations - but it does mean that they are becoming increasingly marginal contributors to informal science education.

Twenty years ago, science center enthusiasts used "interactivity" as their battle cry in the assault on tradition-bound museums. Ironically, if these same enthusiasts cannot keep pace with new interactive media, we may see the end of the science center's key role in informal science education.

Drew Ann Wake is with Livewires Designs, Ltd., 4-5, 550 Beatty Street, Vancouver, BC, Canada V6B 2L3. Phone (604) 687-5016; fax (604) 687-5028.

IRAQ'S 'SCIENCE DAY"

Saddam Hussein, the president of Iraq, has ordered the country's scientists to celebrate a national 'science day' every year on January 18. This date commemorates the anniversary of the first Iraqi Scud missile attack on Israel during the 1991 Gulf War. It was chosen for its "historical, national and pan-Arab significance", according to an Iraqi radio report.

- Nature, vol. 383, 3 October1996, p. 374

NEW NEH PUBLIC PROGRAM GUIDELINES

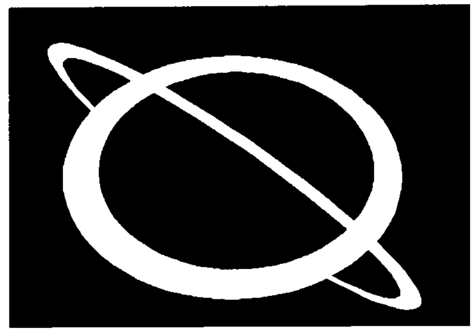
The National Endowment for the Humanities has revised the application guidelines for its Division of Public Programs. There now is only one set of guidelines for the division's four program areas - libraries and archives, media, museum s and historical organizations, and public humanities projects. Copies of the new guidelines may be obtained from NEH's public information office, (800) NEH-1121; e-mail: info@neh.fed.us; or downloaded from http://www.neh.fed.us.

DISCOVERY CHANNEL SCIENCE STORE TO BE BUILT IN NEW WASHINGTON SPORTS ARENA

The Discovery Channel is continuing its aggressive move into science-based retailing and entertainment. The cable television organization, which acquired the Nature Store chain last summer, recently announced a new commercial initiative in the MCI Arena, set to open in downtown Washington next fall.

A 25,000 square foot store (ten times the size of an average mall store), spread over three floors, will be heavily themed with sets designed to emulate the land, sea and air. The ground floor will feature displays that center on the ocean and dinosaurs, possibly with areas that will allow shoppers an undersea view. The second floor will be dry land, with displays of animals and human accomplishments. The top floor, with a planetarium-like ceiling, will tantalize shopper/visitors with displays on flight, space travel, and the world beyond earth.

Discovery Channel also recently announced a 14,000 square foot Discovery Channel Store as part of an entertainment-oriented project led by Sony in San Francisco.



PLANETFEST '97

Planetfest '97, a three-day international conference and exhibition, will take place at the Pasadena Convention Center, Pasadena, CA, July 3-6, 1997. Planetfest '97 is a celebration of international cooperative and collaborative planetary exploration, with thousands of attendees witnessing the landing of the Pathfinder on Mars and real-time images of the Red Planet.

Planetfest '97 will host special exhibitions, hands-on activities, interactive technological programs, and a demonstration of the power of the Internet as Planetfest '97 reaches an international audience with a worldwide Internet presence, including presentations, debates, and discussions by some of the most renowned and popular scientists today. Through a variety of interactive exhibitions, seminars, and displays, Planetfest '97 is designed to involve humankind and to open the mind and the senses to the greatest adventure of all - planetary exploration.

Platefest '97 is presented by The Planetary Society, a nonprofit organization commited to making new ventures in exploration happen around the world through creative research test programs, astonomical observations, student activities, studies, conferences, and workshops. Founded in 1980 by Carl Sagan and Bruce Murray, The Planetary Society is the largest non-governmental space organization in the world, having a membership of more than 100,000.

Information on Planetfest '97: Cindy Jalife, The Planetary Society, 65 North Catalina Avenue, Pasadena, CA 91106; (818) 793-5100, fax (818) 793-5528.

THE INFORMAL SCIENCE REVIEW
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FALL/WINTER 1996/7 SCIENCE/NATURAL HISTORY TRAVELING EXHIBITIONS REPORT AVAILABLE

The largest and most comprehensive issue of the Science/Natural History Traveling Exhibitions Report now is available. The Fall/Winter 1996/7 issue contains descriptions of over 300 exhibitions of varying sizes, prices and topics, lists of previous exhibition venues, a section devoted to exhibitions and exhibition elements for sale and several indices. The exhibitions are listed in six categories - natural history, science, environment, children, anthropology and art and science.

The publication of the Fall/Winter 1996/7 Report follows the Traveling Exhibitions Roundtable held on October 28 as part of the Annual Conference of the Association of Science/Technology Centers. More than 40 people attended the Roundtable - sharing ideas, announcing new traveling exhibitions, and arranging exhibition tour schedules.

The next scheduled Roundtable is at the Annual Meeting of the American Association of Museums in Atlanta in late April, 1997.

An annual subscription to the Science/Natural History Traveling Exhibitions Report (two issues) costs $30.00; single issues are available for $20.00. Order from Robert Mac West, Informal Science, Inc., P.O. Box 42328, Washington, DC 20015, using the form on p. 3.

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