A Model for Museum Outreach Based on Shared Interactive Spaces

Carol Strohecker
Mitsubishi Electric Research Laboratories
201 Broadway, Cambridge MA 02139 USA; 617-621-7517; fax 617-621-7550; stro@merl,com

Just as museum professionals and visitors are becoming more accustomed to preparing, seeing, and using computers in exhibits, the possibilities for interactivity are mushrooming with the expansion of computer networks. Researchers are beginning to develop environments in which many people can be "present" simultaneously. The current contexts typically include meeting places and some type of game-playing, but the milieus present possibilities for serious learning as well. In this paper I describe some of the history of networked multiuser spaces, sketch aspects of a learning environment and online community, and explain how this example suggests a model for museum outreach.

The model addresses a dilemma in museum education: designing for smooth traffic flow through exhibit areas works against possibilities for time-intensive involvement with materials and ideas, which leads to learning in any deep sense.

The Development of Networked Multiuser Spaces

Systems for simultaneous use by many users have evolved through the convergence of several pathways.

Since the earliest days of the Internet, facilities such as electronic mail and the "talk" function have enabled communication between users sharing a system. Electronic mail allows sending and replying to messages according to one's own schedule and convenience; on Unix systems, users can use the "finger" program to find out who else is on the system at the same time and the "talk" program to initiate and sustain a volley of text messages with them. These facilities are normally used in the context of the workplace. More and more systems feature multimedia capabilities for electronic mail, and functions reminiscent of "talk" are showing up in environments that include images as well as text.

Meanwhile, a genre of game-like environments also took advantage of Unix multiprocessing: so-called MUDs and MOOs[1] evolved from early examples of text-based interactive fiction. The earliest of these games often had a dungeons-and-dragons sort of theme, and individual users would type keyword commands that allowed them to navigate through prose descriptions of a castle or some other space that they imagined as they went along. To the user's typed instruction, "go north," the program might reply, "You are in a dark room. A candle casts shadows on a table and chair. To the left of the table you see a doorway revealing a faint reddish glow from a nearby room. Suddenly you hear a crash behind you." The user can infer that acceptable keywords following such a description might include "go south," "go west," "go left," or "sit." Each of these, if accepted, would generate a new description that would carry the user/reader further into the space and the narrative.

Gradually, examples of this sort of environment expanded to support more than one user. MUDs characteristically have an associated programming language with which users can extend the space described in the narrative: they may add a new room or piece of furniture, for example. Gradually these languages became better crafted. Some emphasized the technique of "object orientation," which ideally enabled programmer/users to think in terms of the objects described in the environment rather than less intuitive abstractions [Morningstar & Farmer]. Users of MUDs and MOOs also develop cultures that are specific to the space they create. Their social interactions are governed by implicit and explicit rules, some of which the users negotiate among themselves and some of which are set forth by a "wizard" or other special user (often the original programmer of the environment) [Curtis]. A peculiar custom is the adoption of pseudonyms, enabling users to experiment with alternate identities.

As multiuser environments evolve, graphics and speech technologies are supplementing or replacing text. Habitat is a popular environment in Japan, which now runs on personal computers made by FM Towns [Morningstar & Farmer]. Users see themselves as cartoon-like characters who have a limited repertoire of movements, such as handshaking, bowing, and kicking. They can walk through colorful rooms, buildings, and outdoor spaces or transport themselves from one place to another via magical devices that look like phone booths. Part of the screen is reserved for text displays of conversational exchanges that users type to one another. Jingle-like music plays all the while.

In Placeholder, a research environment, users can converse by speaking and hearing one another [Laurel et al.]. A head-mounted display enables a sense of being immersed in the 3D graphics space. The experimental design allows users to pretend to be a crow, snake, or other pre-defined character and experience the world accordingly: "snake" has infrared vision, "crow" users fly by flapping their arms

1 MUD stands for "MultiUser Dungeon"; MOO means "MUD Object Oriented"

while synchronized graphics show the world speeding by from above. Users can leave their marks in the environment, in the forms of graffiti-like cave paintings.

A Sketch for a Learning Environment and Online Community

I recently faced the challenge of addressing several disparate research interests through the description of a collaborative project that would bring together various technologies: real-time, networked 3D graphics; speech recognition and generation; natural language processing; and artificial agents[2] [Rich et al.]. The agenda also included developing an environment that would foster human learning, as well as fundamental research in learning.

Efforts in describing such an umbrella project resulted in a video "concept sketch" of a multiuser environment called "Zircus" [Strohecker 1994]. This imaginary graphical space is characterized as being part zoo and part circus. Animals are not trained to perform unnatural tricks, but roam freely through familiar terrains, in the spirit of the well designed zoos. Visitors are not mere spectators, but creators of acrobatic routines, juggling sequences, and other circus arts. Friends from all over the globe can see themselves represented in cartoon-like form - often, forms that they themselves design. As they wander through various landscapes and interiors, these new-age "pen pals" can converse in different languages with each other and with resident characters (agents). The visitors can also compose and send messages to one another, often drawing from a multimedia database, and invent their own creatures to dwell in the Zircus. Most of the visitors are probably young people, but that is not a rule.

Visitors to the Zircus find themselves in a world where it makes sense to question how people and animals move. Given the international populace, it also makes sense to become curious about unfamiliar languages. The sketch for the learning environment suggests activities that can support explorations of these areas. Users can talk with one another or with cartoon-like robots and animals in different languages, for example, or construct whimsical creatures that walk in interesting ways.

One of the key features of the Zircus is its function as an interface in which access to specialized activities can be spatially located. By opening the trap door in the floor of the tent and descending stairs to an underground workshop, for example, users can play with a "creature construction kit." It, and other activities like it, are modeled after Seymour Papert's description of "microworlds" and his constructionist theory of learning (see Papert 1980, 1990, 1993; Harel and Papert).

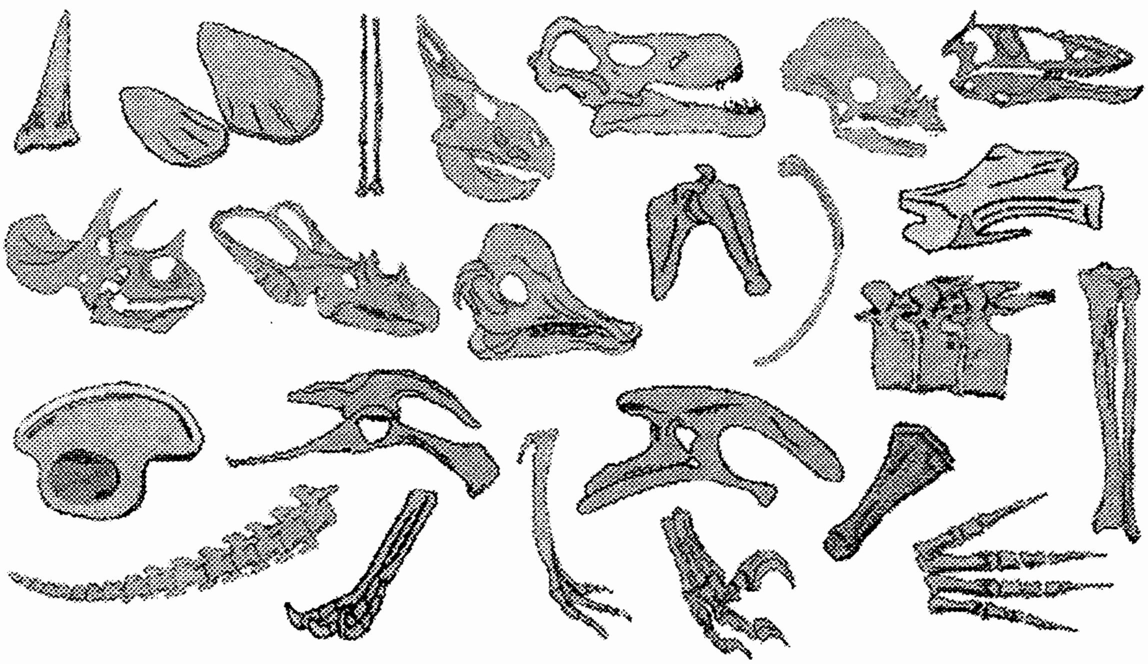
2 "Agent" is a term for any of a variety of computer programs that perform specialized tasks, such as searching or indexing. These programs are often represented anthropomorphically in the user interface.

Microworlds are software programs that are simple in design but powerful in terms of what they enable people to do. The programs consist of fundamental elements of some conceptual area and facilities for manipulating them. By working with the elements, people get in touch with core ideas and develop understandings of the larger topic. For example, in the microworld of "turtle geometry," children draw pictures by directing the movements of a graphical object that looks like a turtle. The turtle has two properties: a position and a heading. By creating pictures through manipulations of these two basic properties, children can come to understand the concept of vector. This building-block idea can, in turn, help in developing further understandings - of angles, the geometries of squares and spirals, etc.

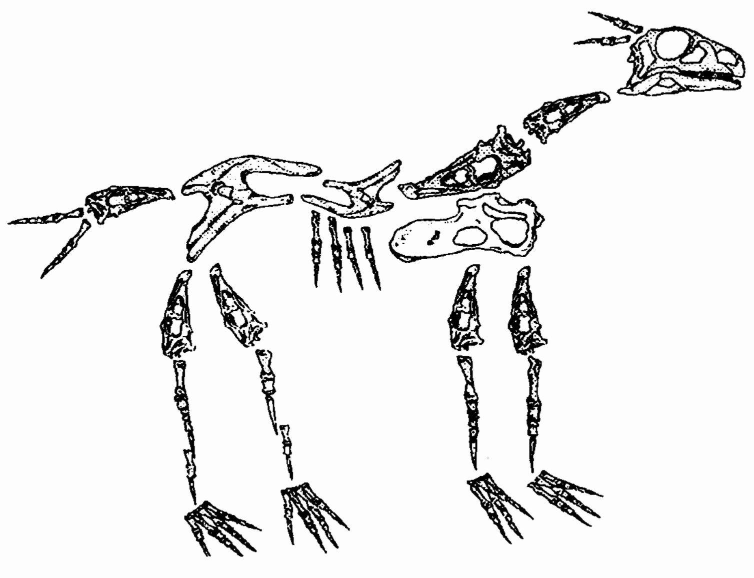
One of the proposed microworld-style activities is a software "creature construction kit" that young people can use in thinking about an aspect of motion study, balance[Strohecker 1995]. With this kit, users can put dinosaur bones together and then test the skeletons to see if they can balance while standing or moving. The software calculates a center of mass and uses it in a simple test for static balance.

Constructing dinosaur skeletons resonates with the activity of paleontologists, but also provides an opportunity to apply Papert's "constructionist" theory of learning. This idea is that people learn by playing and working with objects - spending time, making things they care about, testing their constructions, and showing and discussing them with others. In this view, there is a parallel between making something in the world and developing understandings about concepts that pertain to properties of the constructions. The bones microworld's use of the constructed creature's center of mass as a focus for inquiry into animals' structure and movement echoes a strategy that biologists and roboticists use [Alexander, Gray, Raibert].

The current prototype includes 24 pieces: 3 dorsal spikes, 7 skulls, a shoulder girdle, a rib, single and triple vertebrae, a set of tailbones, a hip, two pelvises, a femur, a radius and ulna, a forelimb, a talon, a claw, and a set of digits. This collection is by no means exhaustive, but provides for rich possibilities in developing varied and interesting creatures. A person who wanted to make a facsimile after a dinosaur picture in a reference book would find most, if not all, of the needed parts. A shapes editor enables changes in form, color, and orientation.

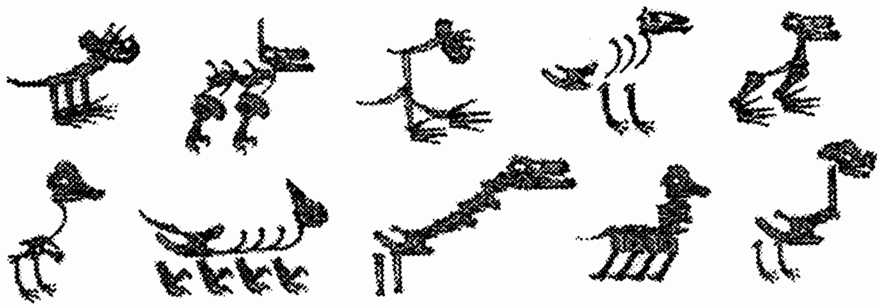


Despite such variety, it's worth noting that acceptable skeletons can be made from just a few parts. This plausible-looking fellow is composed of only three kinds of bones pelvises, skulls, and digits:



Skeletons created in the existing prototype tend to be fanciful but are often carefully crafted:

After adding (and possibly removing) bones and fashioning a skeleton, users have a number of

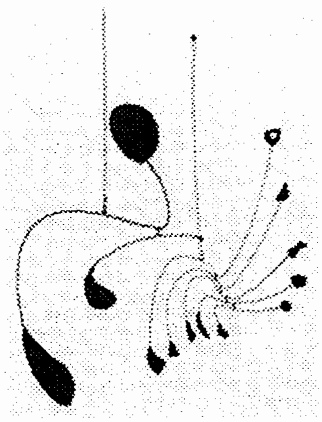


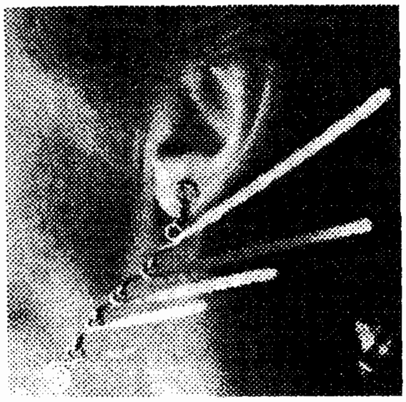
choices. They can see if the creature balances while standing, stepping, or moving at either of two speeds. They can do these balance tests with the "balance lines" on or off; these are the markings that show where the center of mass is and how it projects relative to the base.

Other functions allow users to stop a given movement, revert the creature to its original pose and position, and bring in a background picture to complete the scene. Skeletons move to variations of a public-domain folk tune known by such names as "Them Bones" and "Dry Bones" ("...the knee bone's connected to the thigh bone, the thigh bone's connected to the hip bone..."). The music's tempo corresponds to the creature's gait.

A related construction kit could enable consideration of principles of balance from another perspective. This microworld could share algorithms with the dino skeleton kit, but would have different parts - for assembling mobiles. As in the bones kit, the focus would be on the role of center of mass in balancing. With the mobiles, however, the consideration would be relative to an inverted fulcrum rather than a base, and relevant to many local centers rather than just one.

Thus, people who use both microworlds could find opportunities to work with the concept in more than one way, thereby coming to understand it more deeply. Multiple approaches to a topic can also help to address differences in individual learning styles. Some people have said they would prefer mobiles to dinosaurs as things to make and spend time with. These individuals might appreciate a scaling facility that would enable the mobile microworld to double as a jewelry design kit.

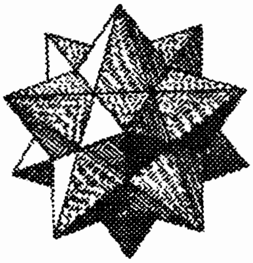


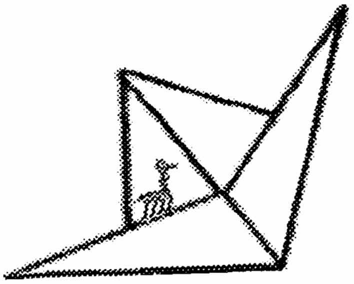


From J. Lipman & M. Aspinwall, Alexander Calder and his Magical Mobiles.
New York, Hudson Hills Press with the Whitney Museum of American Art, 1981

A third microworld would add a new topic area and use the computer network to enable exchanges of objects from one kit to another. The focus is on intuitively exploring topological relationships, through the construction of polyhedral shapes.

This microworld would borrow a strategy from Piagetian research [e.g., Piaget & Inhelder 1967; Strohecker 1991]. In thinking about a complicated object such as a knot or a polyhedron, it helps to imagine oneself as a tiny creature crawling along the surface. (The classic version is a small ant.) This technique encourages spending time and focusing on details that are relevant in understanding the topological relationships that characterize the object. Imagining oneself to be so small as to be surrounded by aspects of the object can engender a style of thinking in which the child becomes very much a part of a system that includes both the object and the child. The knot or polyhedron is no longer an external, bland object, but something that the child can "enter," experience, and come to know.





From I. Lakatos, Proofs and Refutations: The Logic of Mathematical Discovery.
Worral, J., & Zahar, E. eds. Cambridge: Cambridge Univ. Press, 1976.

In this case, the creature would be a small dinosaur skeleton, imported from the bones microworld, and the polyhedron would become a sprawling landscape. As the dino teeters along the vertices, edges, and faces, the relationships that characterize the polyhedron's unique topology become more familiar and enriched, seen in a new way that supplements the original understanding of the construction.

These microworlds are still under development. The designs described here form a set of software construction kits that are interrelated in focus and function. On a networked system, they could enable sharing of objects between users and between the kits. Each microworld could function as a stand-alone learning tool, as part of the interrelated set, and/or as part of an overall networked environment that provides a thematic base.

A Model for Museum Outreach

Many museums' mission includes striving to support learning about topic domains that pertain to the collections. Necessities in museum-exhibit design may work against this goal, though. Designing for experiences of just a few minutes may keep the traffic moving through gallery spaces, but prevents the immersion that a productive learning experience demands (see Papert 1980, 1993; Strohecker 1993).

However, the Zircus sketch suggests a genre of environments that could address both the constraints of a museum visit and the sort of extended, highly personal experience that can support learning. Supplemented by other exhibits and learning materials, microworlds can be installed in gallery kiosks to give visitors a taste of the subjects and modes of interaction they offer. The software could also be available for use outside of the museum: visitors could purchase it in the museum store or dial in to a multiuser providing access.

The association of such an environment with the museum would provide a flexible means for ongoing community support. Between visits, people could take advantage of content that the museum professionals have prepared, discuss their experiences with others in the virtual space, and make their own contributions. While extending the museum's presence within its proximal community, this quickly developing technology could also help to extend a notion of community based on people coming together around shared interests.

References

Alexander, R. McNeill. 1989. Dynamics of Dinosaurs and Other Extinct Giants. New York: Columbia University Press.

Curtis, P. 1992. "Mudding: Social Phenomena in Text-Based Virtual Realities." Proceedings of the 1992 Conference on Directions and Implications of Advanced Computing, Berkeley. Also available as Xerox PARC Technical Report CSL-92-4

Gray, J. 1953. How Animals Move. Cambridge: Cambridge University Press.

Harel, I., & Papert, S., eds. 1991. Constructionism. Norwood: Ablex.

Laurel, B., Strickland, R., and Tow, R. 1994. "Placeholder: Landscape and Narrative in Virtual Environments." Computer Graphics, vol. 28, no. 2.

Morningstar, C., & Farmer, F. R. 1991. "The Lessons of Lucasfilms' Habitat." Cyberspace: First Steps. ed. Michael Benedikt. Cambridge: MIT Press.

Papert, S. 1980. Mindstorms: Children, Computers, and Powerful Ideas. New York: Basic Books, Inc.

Papert, S. 1990. "A Unified Computer Environment for Schools: A Cultural/Constructionist Approach." Proposal to the National Science Foundation. Cambridge, MA: MIT Epistemology & Learning Group.

Papert, S. 1993. The Children's Machine: Rethinking School in the Age of the Computer. New York: Basic Books.

Piaget, J., & Inhelder, B. 1967 [1956, 1948]. The Child's Conception of Space. Langdon, F. J., & Lunzer, J. L., trans. New York: W. W. Norton.

Raibert, M. 1986. Legged Robots That Balance. Cambridge: MIT Press.

Rheingold, H. 1993. The Virtual Community: Homesteading on the Electronic Frontier. Reading: Addison-Wesley.

Rich, C., Waters, D., Schabes, Y., Strohecker, C., Freeman, B., and Roth, M. 1994. "Demonstration of an Interactive Environment for Collaboration and Learning," IEEE Computer, vol. 27, no. 12.

Rich, C., Waters, D., Schabes, Y., Freeman, B., and Roth, M. 1994. "An Animated Online Community with Artificial Agents and Spoken Interaction," IEEE Multimedia vol. 1, no. 4.

Strohecker, C. 1991. Why Knot? Ph.D. diss., Massachusetts Inst. of Technology.

Strohecker, C. 1993. "A View of Learning Environments." MERL Note 93-17. Cambridge: Mitsubishi Electric Research Labs.

Strohecker, C. 1994. "The 'Zircus' Concept Sketch for a Learning Environment and Online Community." Technical Report 94-22, Mitsubishi Electric Research Laboratories.

Strohecker, C. 1995. "Embedded Microworlds for a Multiuser Environment." Technical Report 95-07, Mitsubishi Electric Research Laboratories.