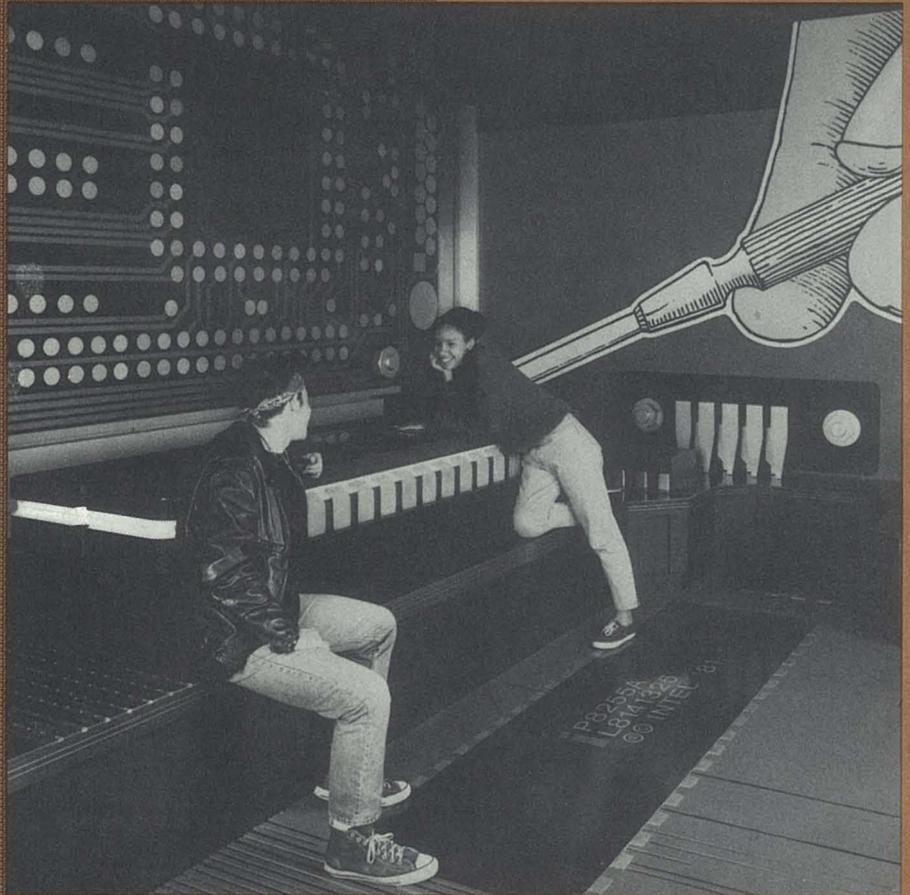


The Computer Museum

Annual Report 1990



The Museum's mission is threefold:

- *To educate and inspire people of all ages and backgrounds from around the world through dynamic exhibitions and programs on the technology, application, and impact of computers.*
- *To preserve and celebrate the history and promote the understanding of computers worldwide.*
- *To be an international resource for the research into the history of computing.*

The Computer Museum
Annual 1990
July 1, 1989 - June 30, 1990

F a c t S h e e t

Boston Opening: November 14, 1984

Background: In 1974, Ken Olsen and Bob Everett saved the MIT Whirlwind computer from the scrapheap. They determined a need to preserve the history of computers and in 1982 The Computer Museum was founded. A public, non-profit organization, it remains the world's only museum devoted solely to computers and their impact on society. The Museum has the richest collection of historical computers and robots in the world.

Facilities: 53,000 square feet; six exhibition galleries; 275-person auditorium (3,200 square feet); Museum Store.

Annual Operating Budget: \$2 million. Income sources: Donations-34%, Memberships-13%, Admissions-26%, Store-16%, Functions-7%, Other-4%.

Audience: 150,000 visitors/year (40% students); over 1 million served through traveling exhibits.

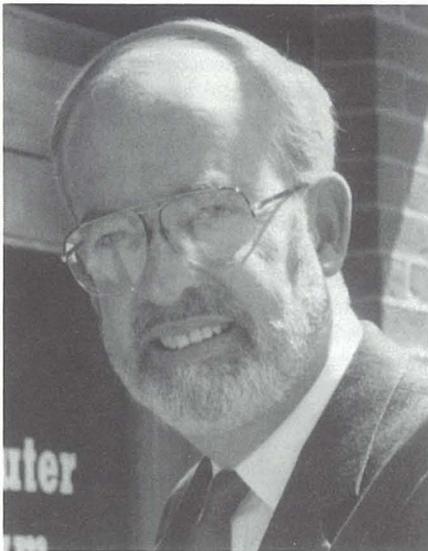
Members: 1200 individuals from 45 states and 13 countries; 150 corporate members worldwide.

Museum Hours: Winter: Tuesday - Sunday, 10am to 5pm, Summer: Daily, 10am to 6pm, Fridays until 9pm.

Admission: \$6.00 for adults; \$5.00 for students and seniors; free for Museum members. Half price Saturday, 10am-noon. Group rates by arrangement.

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The past fiscal year has been filled with good news for the Museum. Dr. Oliver Strimpel was appointed Executive Director, the Museum was awarded first time grants by several major national foundations, and the Museum ended the year with an operating surplus. It was also the year when the Museum funded, developed, and opened the largest and most successful exhibit in its history—The Walk-Through Computer™.

This year's annual report departs a bit from the usual annual report format in that it focuses on the conception, design, and construction of one exhibit. But this is an extraordinary story. It is a testimony to the vision and persistence of Oliver Strimpel, and his ability to attract the best possible designers, illustrators, engineers, and advisors to the Museum.

The history of the exhibit's development is not unlike the creation of a new technology. It includes false starts, serendipitous opportunities, intense creative activity, and timely financial support. As this report describes, The Walk-Through Computer project received the benefit of extraordinary volunteer, professional, and financial resources. On behalf of the Board of Directors, I thank the many people, companies, and foundations that contributed to the exhibit and the Museum, thereby making this past year such a great success. We invite new friends to join us and share the experience of building an important international institution.

Gardner C. Hendrie
Chairman of the Board of Directors



This has been the best year in The Computer Museum's history from both a programmatic and financial perspective.

On the programmatic front, we concentrated on pushing ahead with our long range exhibit development plan for the remaining space in the Museum. The plan calls for exhibits that address four general themes: how computers work, the evolution of computing, the applications and impact of computing, and people and computing.

This past year, we successfully completed an exhibit which addresses the first theme. The Walk-Through Computer™ introduces visitors to the workings of computer hardware and software technology. Thanks to the commitment of the sponsors who funded this groundbreaking project and an immensely talented team, we managed to complete the extraordinarily challenging task of building a giant working replica of a computer in record time. The feature article in this report tells the story of its creation.

With the help of a planning grant from the National Endowment for the Humanities, we also began developing an exhibition that deals with the second theme, the evolution of computing. Opening in June 1991, "People and Computers: Milestones of a Revolution" will present nine key milestones in the evolution of computing within their proper historical context, together with a critical examination of the ways computers have affected people's lives. The centerpiece of each milestone will be a life-size re-creation of a computer environment typical of each era. This project is being directed by our most experienced exhibit developer, Greg Welch, who developed the Museum's successful traveling exhibit, "Computers in Your Pocket," among other projects.

Looking ahead to 1992-93, two other major exhibitions will treat the many uses of computers. The first, the Computer Discovery Center, will focus on the applications of the personal computer to people's everyday work and play. Developed jointly with The Boston Computer Society, this exhibition will offer hands-on experiences with word processing, graphics, calculating, education, special needs, desktop publishing, and multimedia production. The second, The Networked Society, will reveal the large-scale commercial applications that underpin modern society, from travel and communications to finance and retailing.

In response to requests for our exhibits from museums and science and technology centers around the world, we have begun an Exhibit Kits Program. This Program has enabled us to create and distribute copies of our most popular and effective exhibits. A prototype of one Kit was installed in the Franklin Institute's new Future Center where it has become one of the most popular exhibits in their computer exhibition! With seed funding from the National Science Foundation, the Hearst Foundation, and the American Association for Artificial Intelligence, implementation has begun under the direction of the Museum's Exhibits Engineer Dan Griscom.

The Kits enhance the Museum's national educational impact while providing an important new source of revenue to support the Museum's education programs.

The Museum's artifact acquisitions included narrowly saving a 1953 computer— Gene Amdahl's WISC; another highlight acquired for the collection is Ivan Sutherland's helmet from the late 1960s, a forerunner of today's virtual reality head-mounted displays.

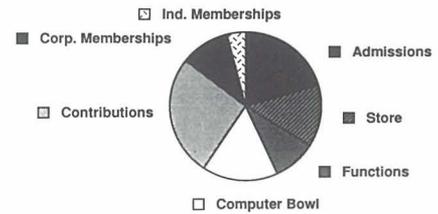
The Museum continues to strengthen its financial status. In the fiscal year ending June 30, 1990, the Museum finished with a balanced operating budget of \$1.5 million. We substantially increased our revenues from admissions, the store, and functions (rental of our space for receptions, press conferences and other activities). In addition, the Annual Fund Appeal and Corporate Membership Program have gained momentum, with significant growth in each area. In April, we held our Second Annual Computer Bowl®, won by the West Coast team in a most dramatic finish. The Bowl has become an important source of support for the Museum.

With The Walk-Through Computer, a \$1 million project, the Museum reached a new level of visibility, locally, nationally, and internationally. Our educational video *HOW COMPUTERS WORK: A Journey Into The Walk-Through Computer* extends the educational impact of the exhibit to millions of people beyond our walls.

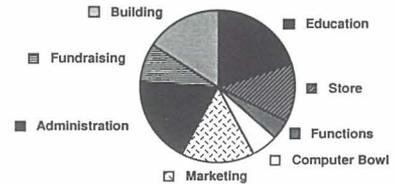
The Museum has an extraordinary power to expand people's horizons through its unique mix of activities for informal learning. This year, with The Walk-Through Computer, we have taken a big step forward in developing this capability.

Dr. Oliver B.R. Strimpel
Executive Director

Operating Income



Operating Expenses



BUILDING THE WALK- THROUGH COMPUTER

Building The Walk-Through Computer™ was a large and complex undertaking. It covers 5,300 square feet and weighs more than eight tons. The giant ribbon cables are composed of a third of a mile of colored two-inch plastic tubing and weigh 1,500 pounds. Ten computers, nine videodisc players, five video projectors, nine video monitors, and a slide projector control the lighting and special effects, and interactive stations. Ninety minutes of original computer animation were produced. More than 800 square feet of silk were used for silk-screening and 325 sheets of plywood make up the core construction. Some 2,000 feet of Tivoli™ lighting cover the floor. More than 100 gallons of lacquer, vinyl, and epoxy paints in 200 custom-matched colors were used. Almost 340 lighting units of various kinds provide the 10,000 watts of light built into the exhibit.

From design to implementation, more than 150 people—carpenters, model makers, electricians, electrical and mechanical engineers, lighting designers and technicians, software engineers, computer animators, illustrators, typographers, painters, silk-screeners, and volunteer jacks-of-all-trades—worked directly on the exhibit. They made The Walk-Through Computer a reality.

Origins: January 83-September 86

The origins of the idea for a larger-than-life exhibit go back to 1983, when Oliver Strimpel decided to come to The Computer Museum. He had worked at The Science Museum in London and at Britain's National Museum of Photography, Film, and Television. Like The Computer Museum, these institutions combined the preservation of history through collections of artifacts with a mission to educate the public through dynamic exhibitions. Both museums had built large-scale models: The

common to all computers. The exhibit worked well in its first objective, but quite poorly in the second. For example, while it was awe-inspiring to compare the SAGE's huge drum unit with a small floppy disk of today, this did not help visitors grasp what a floppy disk was or how it worked.

In 1984, the debate shifted to whether it was more pressing to concentrate on explaining how computers work or whether further exhibits on computer applications, such as "The Computer

Concept Stage: October 86-July 88

In 1988, Gardner Hendrie, Chairman of the Exhibits Committee and of the Museum's Board, led the formulation of an exhibition policy. The committee concluded that the exhibitions were to be primarily educational, with a wide appeal that would inspire people, especially younger visitors. Exhibits should principally address four questions: "How do computers work?", "Where do computers come from?", "What do computers do?", and "Who made computing develop?" As the answers to the first two questions would constitute a good introduction to the Museum as a whole, it was decided to build them near the Museum entrance.

Oliver was intrigued by the challenge of addressing the first question and decided that something extremely dramatic and larger than life would be needed. He had pictured a giant landscape of the inside of a computer that would make visitors catch their breath when they first saw it. He knew that the correct choice of designer would be absolutely critical in this kind of project.

At this point, Richard Fowler, the designer with whom Oliver had worked on his last Science Museum project in England, made a fortuitous visit. Richard and Oliver talked about the overall plan for the Museum and about building a giant computer that would answer the question "How do computers work?"

Before the idea could go farther, Oliver knew that potential exhibit supporters had to see a drawing of an oversized computer in the Museum space before they would believe that this was possible, let alone fund it. Richard, with his experience of large-scale exhibits (a nuclear reactor, a television studio), was the obvious designer for the job. Then, Founding President Gwen Bell, on a visit to England, secured a year's leave of absence for Richard to come to Boston to design the giant computer.

Seed Stage: August 88-June 89

In November 1988, Oliver presented the idea to the Board of Directors with Richard's first drawings that showed the exhibit and its location on the fifth floor, replacing part of the SAGE exhibit. The plan called for a mix of realism and abstract representation that is strikingly similar to the final version. For example, Oliver described a "processor island"

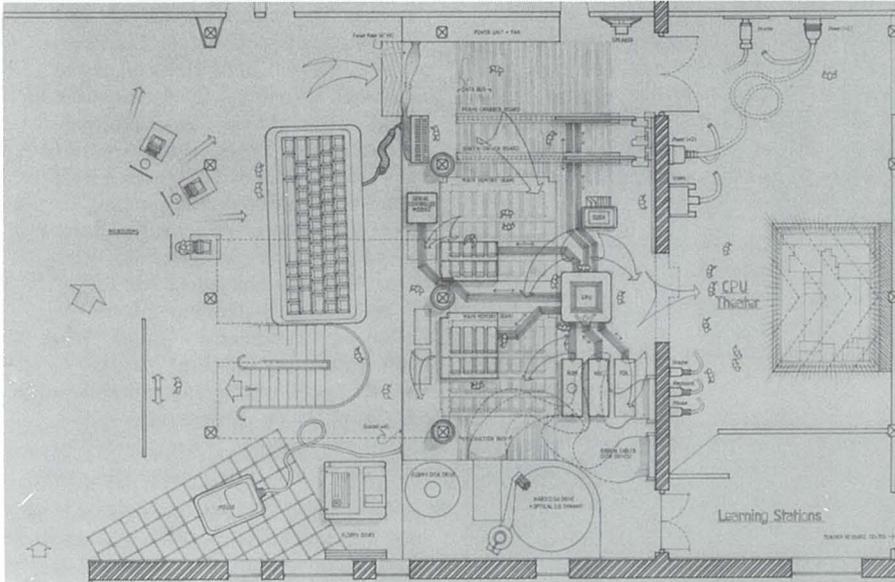


The SAGE Exhibit. Oliver tried to figure out how to use the components of the SAGE computer to show how computers work. While the huge difference between historical components and today's equivalents is a fascinating story, it does not directly help in the understanding of computers.

Science Museum, a nuclear reactor, and the Bradford Museum, a reflex camera. In the summer of 1983, the National Museum of Photography opened as a roaring success, and Oliver came to The Computer Museum in January 1984 as Curator.

In November 1984 when the Museum opened at its Boston location, the first exhibit seen by visitors was a very large computer of the 1950s, the SAGE. The exhibit was intended both to present an example of computing in the days of vacuum tubes and to reveal and explain the function of the various components

and the Image" gallery (which Oliver developed for the original Museum opening in 1984), should be built. The latter view prevailed, with the result that in 1986 Oliver started work on "Smart Machines," a gallery on artificial intelligence and robots, which opened in 1987 as the first addition to the Museum since its opening.



1989 concept drawing for *The Walk-Through Computer*.

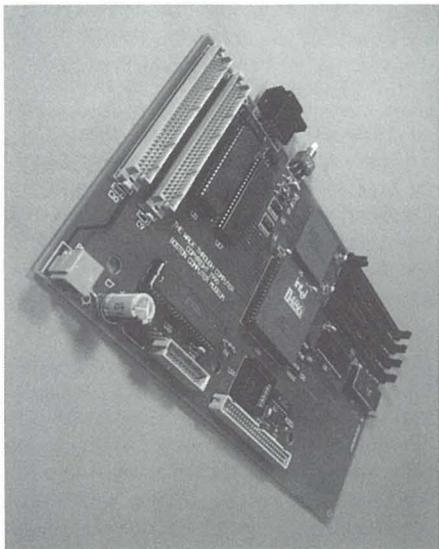
that combined computer animation of a fetch/execute cycle with views of a real microprocessor under magnification—precisely the effect built into *The Walk-Through Computer's* microprocessor. The exhibit was projected to cost \$750,000.

In March 1989, Mitchell Kapor had agreed to a \$250,000 gift from the Kapor Family Foundation for a major, substantive project at the Museum. Here, we felt, was a perfect candidate! In July, Oliver made a presentation to Digital Equipment Corporation. Of all the Museum's exhibit plans, the giant computer captured their imagination the most. The one-year contract with Richard Fowler was confirmed, and an opening date for the exhibit set for June 23, 1990.

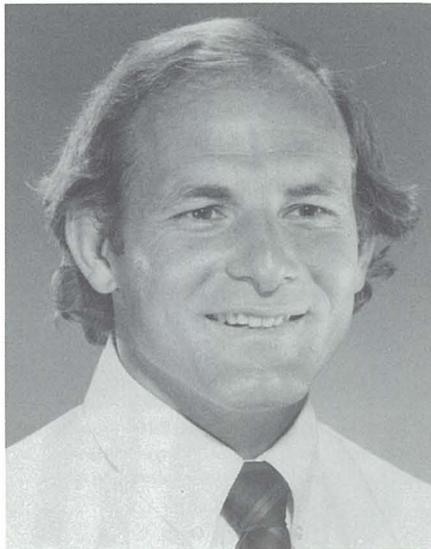
Before the exhibit ideas solidified, the Museum wanted to solicit the widest possible expert advice on the wisdom of building a larger-than-life computer. To this end, Oliver established an advisory committee. Early meetings of this committee focused on the basic design concept for the exhibit. Three competing ideas emerged. One, similar to Oliver's original proposal, called for both the inside and outside of the computer to be based on the real physical hardware, with cutaways and insets featuring computer animations and smaller physical models. Some advocated an enormous contoured landscape of a greatly enlarged microprocessor. Others felt priority should be given to input and output devices because these provided a bridge between the exhibit and visitors' prior experiences.

A second idea, referred to as the "Alice in Wonderland" model, would have had a realistic exterior with doorways opening into unexpected places. One doorway would lead into the computer's chassis, while a second would be a sort of "rabbit hole" into space representing the realm of software. Museum Director of Education Adeline Naiman was especially concerned that children would have a sense of moving into another world at another scale.

A third concept was totally abstract—the flow of logic and data inside a computer would be represented by a system of "whirling ping-pong balls." This approach stemmed from the desire to explain the essence of computing using a very simple implementation. It was advocated strongly by those who felt that



The prototype 1:1 board for *The Walk-Through Computer*



"Real" computer architect Dave Patterson helped ensure the realism of the giant computer's design.

the Museum's current exhibits were too hardware-oriented. Philip and Phylis Morrison, who had helped conceive the Giant's Desk Top at the Boston Children's Museum, described it as an exhibit that was really popular with long staying power. Signe Hanson, from the Children's Museum, warned of the heavy wear and tear on such models. Their enthusiastic caution and experience helped guide the rest of the group.

As July and the arrival of Richard, the exhibit designer, drew near, Oliver pressed the advisors to reach a conclusion. The critical element to them was: What would a typical visitor — and we thought of an eleven-year-old as our example — relate to best? The decision became clear: the first, realistic model would work best because it would be identified with something visitors had already seen.

Design Stage: July-December 1989

As soon as Richard arrived in June, he and Oliver set the goal of completing the design, hiring the project team, securing the funds, and determining the giant computer's program and the animation of the internal workings by the end of December. If this was achieved, an opening in June 1990 would be feasible.

The Design

Richard quickly came up with the idea of perching a giant monitor on the sixth floor, resting on top of a chassis on the fifth floor. This exploited the only two-story vertical space within the building to house a giant computer in its typical configuration. The ceiling height limited the maximum scale-up of the monitor to a factor of twenty. The flatter shape of the computer chassis and motherboard, however, permitted a scale-up factor of fifty inside the computer.

As thinking progressed on the interior structure of the giant computer, a gap in the Advisory Committee became apparent—no one had ever designed a real computer. Fortunately, computer architect David Patterson, Professor of Computer Science at Berkeley, a leading advocate of RISC architecture, and Computer Museum Board member Gordon Bell, Chief Scientist at Stardent Computer, were delighted to work on this problem. These two “real” computer architects became the team's mentors, and ensured the realism of the giant computer's hardware design.



Some members of the exhibit's Advisory Committee are shown here. Standing from the left: Robert Semper, Jonathan Rotenberg, Daniel Dennett, Richard Rubinstein, Signe Hanson, Art Bardige, Lynn Rankin, Dan Griscom, Michael Chertok. Sitting from the left: Philip Morrison, Gwen Bell, Allison Druin, Phylis Morrison, Adeline Naiman, Oliver Strimpel.

Initially, a Harvard architecture had been chosen in which separate sets of connecting wires (buses) on the motherboard are used for instructions and data. It was hoped that this would help visitors distinguish instructions from data as they watched a program executing in slow motion inside the giant computer. But both Dave and Gordon resisted. “That is not what most computers are like,” they said. “If you want this to be realistic, and look like the desktop computer that a visitor might go home and open, then a serial, Von Neuman architecture is the correct choice. You'll just have to work out a way to explain it.”

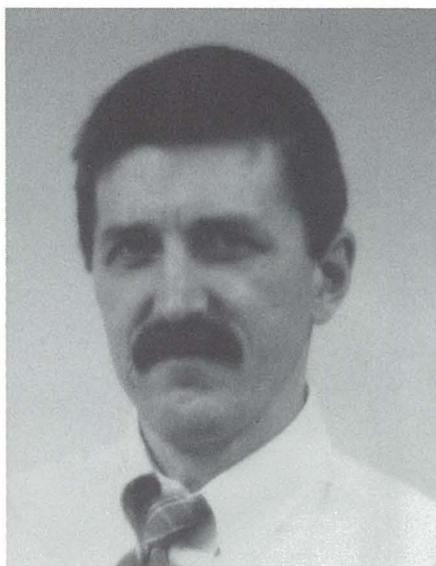
By late December, the computer architecture team was given some additional constraints. The Museum had decided to use an Intel 486 microprocessor, a DEC 8-platter five-inch hard disk drive, and four banks of RAM chips (SIMMS) in the exhibit. The team then realized that if all the components were incorporated, there would be no room for people. David remarked, “This is the first time that I've had to be constrained by the fact that people need to fit around the processor.” This led to the idea of “steam-rolling” some of the components into the floor so that their outlines were visible as flat shapes on the floor.

Gordon and Dave suggested that just as the first drawing had helped crystallize ideas, an actual motherboard should be fabricated and used as a basis for the exhibit design. Immediate priority was given to the preparation of circuit drawings for building the “1:1 board.” Donald Glass, president of DGA Associates in Wilmington, Massachusetts, lined up the necessary suppliers to build the prototype.

Just as the inside of the computer changed, the outside evolved. Some of the keys on the keyboard were steam-rolled to provide a “walk-through” keyboard that would include a cut-away view of the inside of one key. A pointing device was needed. But a twenty times life-size mouse would be larger than a bumper car and would not be safe, especially for children. A stationary trackball was selected as the alternative. The trackball details were solidified by a lucky event. While visiting Scott Fisher at the NASA Ames Research Center in December, Oliver was introduced to the designer of the Kensington trackball. And by January 1, on schedule, Kensington Microwave Ltd. was providing the information needed to reproduce their trackball design faithfully on a twenty times life-size scale.



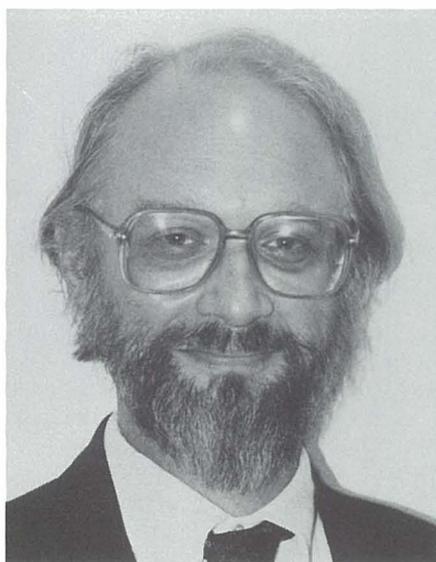
Richard Fowler, Exhibit Designer



Chip Morrison, Exhibit Developer



Dan Griscom, Technical Consultant



Alan Symonds, Technical Director

The Team

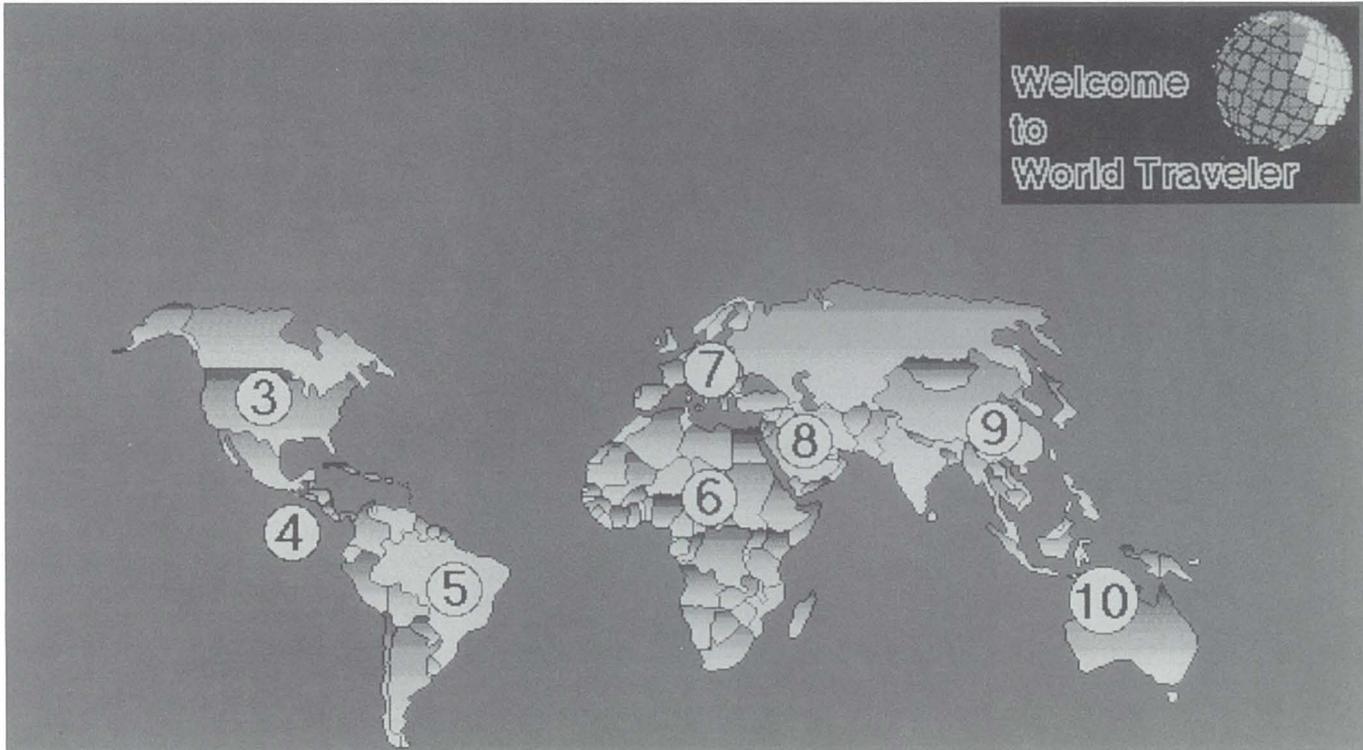
In addition to Richard as the exhibit designer, three other people became project leaders. Donald "Chip" Morrison, who was about to complete his Ph.D. from the Harvard Graduate School of Education, was signed on as Exhibit Developer. He would plan the educational messages and write all the exhibit text. Dan Griscom, Exhibits Engineer at the Museum, took on the role of determining the metaphors that would be used inside the computer to show how the computer worked. Alan Symonds, a theatrical lighting engineer who had worked on the Smart Machines Theater in the Museum's Smart Machines gallery, was signed on as the Technical Director for special effects and electronics.

In addition, two outside contractors were engaged. F.W. Dixon Company, of Woburn, Massachusetts, an experienced exhibit and model-making firm, was selected as the main fabricator. The contract, signed in early September, gave Dixon just 10 months to complete the construction. The three-dimensional fabrication would eventually involve 35 Dixon employees, four supervisors, fifteen subcontractors, and more than a hundred other vendors.

The second was award-winning illustrator, David Macaulay, author of *The Way Things Work*. David was intrigued by the prospect of applying his talents to an exhibit. He enthusiastically moved beyond his role as an advisor to become the Exhibit Illustrator. This allowed us to place most of our explanations of how the components worked into illustrations, keeping text (which most visitors are reluctant to read) down to a minimum.

Choosing an Application

Throughout the fall, the advisors and staff were grappling with the question: What should The Walk-Through Computer be doing? Not only would this determine what appeared on the screen and how the keyboard and trackball would be used, but it would also provide the framework for the explanations of what the various components were doing inside the computer. Thus it was decided that the application had to (1) involve both processing and memory (requiring significant use of disk); (2) require a genuine, but brief (no more than 90 second) interaction with the visitor; (3) be graphical; (4) be fun for all ages; (5) be a typical type of task



World Traveler was selected as the program to run on the giant computer because it met all seven criteria.

appropriate for a computer; (6) use a readily explainable algorithm, and (7) be implementable in time.

For several months, “face matching” was seriously considered. This program would capture an image of a visitor’s face with a TV camera, compare the visitor’s features with those of celebrities, and select the closest match. It would be popular because people are always fascinated by exhibits that involve their own face. In fact, it met all the criteria except the last one: none of the team or volunteer consultants could get a prototype to operate.

In December, the second candidate application, “World Traveler,” was selected. In World Traveler, the visitor selects a region of the world using keys on the keyboard. The computer then shows a map of that region and invites visitors to select a starting city and a destination city by moving an arrow on the screen with the giant trackball. The computer searches for the shortest path between the two cities. It then steps through the route on the map, segment by segment, showing images of the cities passed through along the way. World

Traveler appeared to meet all of our criteria well: processing was required to find the shortest route; disk access would be needed to retrieve the images of the cities; the interaction with the trackball and keyboard was an integral part of the program; the maps and city images were graphical; the element of surrogate travel made it an exciting program to use; route-finding and image retrieval were representative of widespread search and database applications; a search algorithm seemed easy enough to explain, and lastly, the program could be implemented in-house.

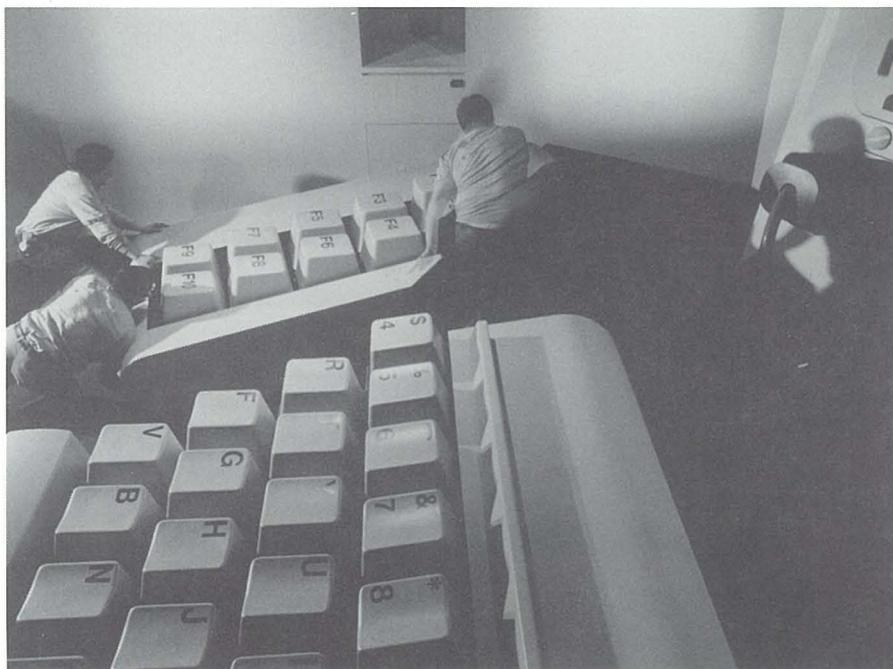
Viewports

A major series of discussions centered on the design of the “viewports,” the visitors’ view inside the giant computer’s components, such as the CPU, the graphics board, the RAM, and the disk drive. On the one hand, it was desirable to show visitors what they would actually see. In the case of the CPU, RAM, and UART (interface chip), it would be the etched patterns on the surface of a silicon chip. On the other hand, visitors might want to see what each component was actually doing as it executed the World

Traveler program. As we tried to reconcile the realistic “silicon” view with an explanation of the function being performed, it became apparent that any attempt to superimpose the two in the same image would lead to a less clear view of each one separately.

Realism was pursued first. The most authentic view would be a high resolution photographic image of the chip surface. Engineers at Digital Equipment Corporation had shown members of the team some video sequences of working chips taken through an electron microscope. The team was thrilled to see the actual voltage levels change while the chip was operating. The decision was made to incorporate electron microscope sequences into the silicon view.

But now a bridge was needed between a photographic blow-up of a chip and the electron microscope sequences so that visitors would know they were looking at two views of the same thing. Swivel 3D, a program for doing three-dimensional animation developed by San Francisco-based Paracomp, seemed to provide an answer. Special animation would be



The keyboard is swung into position. This photo appeared on the "Works in Progress" page of the New York Times Magazine.

generated to "fly" into the electron microscope view from the photographic view. When Sean McKenna, Vice President of Marketing at Paracomp, was presented with the project needs, he offered the Museum six weeks of service from Drew Huffman, their top animator. The decisions to construct a prototype printed circuit board as the basis for fabricating the giant motherboard and to acquire the scanning electron microscope images took the design team to the diametric opposite of the abstract "ping-pong ball" model. A motto pinned up in more than one office during this period expressed this tendency in one telling phrase— "Make It Real."

Fund-raising

In September, Mitchell Kapor committed his \$250,000 grant towards The Walk-Through Computer. A month later, Digital Equipment Corporation made a three-year grant to the Museum, starting with \$150,000, plus equipment, for The Walk-Through Computer. Within weeks, a \$250,000 grant from the Alfred P. Sloan Foundation put the project within \$100,000 of its goal. In December, a fundraising trip to California brought in Apple Computer and Intel, each with a \$50,000 donation and a commitment for

technical and equipment help with the project.

Larry Tesler, then Vice President of Research and Development at Apple, said, "I'll get you nine Macs, including a machine that you will want but I can't tell you what it is." It was to be one of the first Macintosh IIfx's, whose speed was to become critical for the World Traveler application running on the giant computer.

At Intel, David House and the 386/486 microprocessor marketing/engineering organization provided the funds and expert advice. In discussions with the group, we decided to base the giant CPU on the recently introduced 486 microprocessor. Ann Lewnes from the group was invited to participate in one of the final brainstorming sessions. A month from the design completion deadline, Ann and Steve Blank from SuperMac, Jon Rubinstein from Stardent, Sally Rosenthal from Digital Equipment Corporation, Gordon and Gwen Bell, and Oliver Strimpel generated ideas about the special effects to reveal the flow of information along the motherboard. Ann Lewnes said it was like listening to a session of Intel engineers while they were still free to play with the design specifications of a new product.

At this point, it was becoming clear that the \$750,000 budget set 18 months earlier might be too low. Fortunately, several other funders added their support: AT&T, intrigued by the project's educational potential, committed \$50,000, and Maxell committed \$25,000 (in addition to their \$12,500 contribution of the previous year). By January 1, 1990, \$825,000 had been raised.

Designing the Publicity Roll Out

In late December, Jan Del Sesto, Director of Development and Public Relations, and Gail Jennes, Public Relations Manager, were given the go-ahead to call together the Museum's crack PR consultants. The group, including Christopher Morgan, Roxanne Frisiello, Sheryl Schultz, Wendy Germain, Richard Eckel, Lewis Karabatsos, and Joe Grillo, developed a roll out strategy to publicize the exhibit internationally. They decided to obtain early coverage by going after the British press and the "Works in Progress" page of the *New York Times Magazine*. This was successful, and the exhibit's appearance in the *London Daily Telegraph* and the May 20th issue of the *New York Times* helped attract unprecedented international coverage for the opening.

Specifications: January-March 1990

By January 1st, the general form of all the computer's components was determined; the project now entered a phase of converting the general into the specific. Designs were sent to Dixon and converted into working drawings; fabrication at the Dixon workshop began, starting with the giant monitor and keyboard. A similar process started with David Macaulay. The Museum provided him with real components to dismantle, and explained processes to him in detail. He then translated the material into illustrations which were critiqued and steadily improved over several iterations. Many of the developments were now taking place in parallel, as the size of the team increased and individual team members took on separate tasks. In February Oliver was named Executive Director, placing great demands on his management skills as he took on new responsibilities while continuing to direct The Walk-Through Computer project.

Application Program

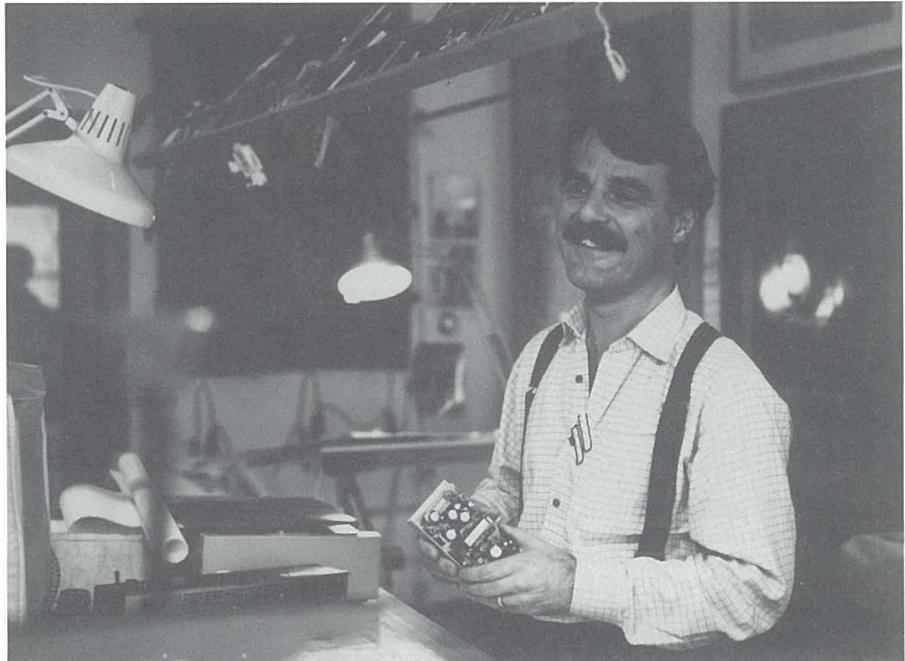
David Greschler, an experienced Hypercard programmer, was hired to implement the World Traveler program. It became clear that the best approach was to use Supercard, a program similar to Hypercard but with color. The compute-intensive parts of the program, such as the route-searching, would be implemented in the programming language C as external commands. Major cities around the world would be represented, resulting in some four hundred possible destinations. Tom Restivo was employed to collect, select, and digitize the city photographs. It was also decided to give the computer sound, prompting visitors as they used World Traveler and saying the names of the cities along the selected route.

Viewport Animation

Once World Traveler was selected as the application, Dan Griscom, Drew Huffman, Alan Symonds, and Chip Morrison began to spell out the nature of the visitor's journey into the program. Drew started to create animated sequences using Swivel 3D that showed zooms onto the microprocessor and the disk drive.

At the same time, key members of the team were once again pointing to the need for something more than authenticity. Although engineers and other knowledgeable visitors would appreciate the realism, concern was growing that the average visitor would have difficulty understanding what the computer was actually doing. There was a need, in other words, for a "functional" view of the computer that would complement the "silicon" view.

Seeds for the second breakthrough lay in the donation of another animation product, Macromind Director, from Macromind, Inc., in San Francisco. Dan Griscom, the Exhibits Engineer, took the program home one weekend in early January and came back the following Monday with a short computer animation involving a video image of his own hand carrying chunks of "data" around the screen. Everyone on the team who saw the animation realized at once that the long-sought "functional view" had been found. It was simple, told the story, and was fun. It was soon agreed that the viewports would have to alternate between functional and silicon views.



David Macaulay, who had joined the team as illustrator, was given real components to dismantle. He then translated them into drawings.

Gordon Bell remembers, "We made an immense breakthrough when we decided to show three levels in the viewports—the functional level of the fetch-execute cycles, the photograph of the silicon, and then a fly-down to the gate level with an electron microscope view."

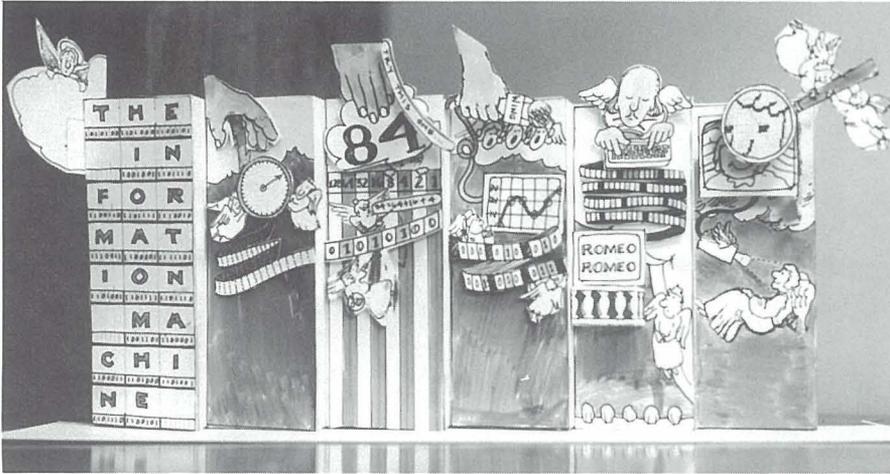
After much debate, the activities inside and outside the computer were decoupled. A full interaction with World Traveler takes about 90 seconds. If the interior were animated at that speed, visitors would only see a blur of light. The decision was made to slow the elapsed time for a World Traveler interaction inside the computer by a factor of about ten, allowing time to show a functional representation of each step of a search. The search would be standardized for a starting city of Columbus, Ohio, and a destination of Boston.



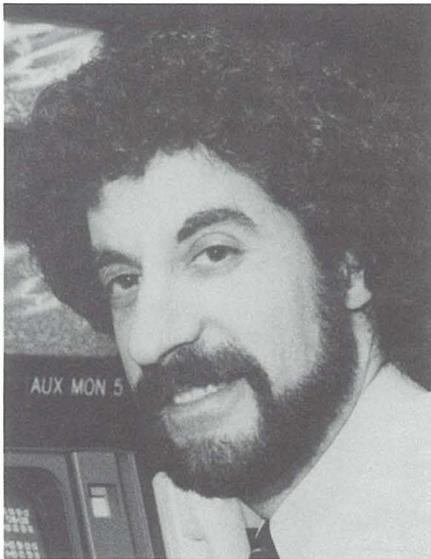
David Greschler, Programmer

Learning Stations

It was expected that for many visitors, The Walk-Through Computer would raise more questions than it answered. How do chips really work? What is the connection between the circuits on the chip and the manipulation of information? How are computers made? Learning stations located nearby would offer visitors some of the answers, with



A cardboard prototype of the Information Machine panels by David Macaulay. Each type of information was presented graphically in a large illustration next to a hands-on interactive enabling visitors to enter their own information and see it encoded as a pattern of bits.



Dean Winkler, Special Effects Video

more explanatory depth and a longer interaction time. Education Coordinator Natalie Rusk had been working with students in grades 7-12 in the Brookline, Mass., Public Schools to find out what they wanted to know about computers. This influenced the design of all the learning stations. One station was created specifically to answer a common question: "What happens when a key is pressed?"

"Journey of a Keypress" shows the sequence of activities involving the UART, CPU, RAM and video display board, all working together to input a

single press of a key at the keyboard and display it on the screen.

"Digging Deeper," the most ambitious station, makes the connection between low-level software and the hardware. Visitors step through the machine-level instructions for the addition of two binary digits, seeing animation taken from the microprocessor's viewport. This and other animation show how logic gates are used to add the binary digits. Then each gate would be shown as an electronic circuit, and as it might appear on a silicon chip.

"Design your Own Computer" invites visitors to combine different processors, video boards, and amounts of RAM to create their own computer. A spinning globe on the simulated computer's screen gives instant feedback on the computer's performance, while an "invoice" gives cost.

"Manufacturing Computers and Software" gives visitors short video introductions to three topics: fabrication of integrated circuits, assembly of computers, and the design and implementation of a software product. The video material was developed by Intel, Apple Computer, and Lotus Development.

The final learning station offers visitors the chance to write and run their own simple program. The challenge here is to instruct a man to find his dog by giving directions on how to go through a simple maze.

Software Theater

The realistic hardware inside The Walk-Through Computer does not reveal how software is made or how it operates. Tony Fernandes, a software engineer at Lotus, became the advocate for a separate space, devoted entirely to the explanation of software. He produced a sequence that served as an inspiration, helped convince the team to create a software theater, and urged Lotus to fund it.

BBC producer Jon Palfreman and Nancy Linde, at work on *The Information Age*, a six-part television documentary for PBS on the history of the computer revolution, accepted the job of producing the film in time for the opening. Working with Museum staff, the pair eventually produced a script that called for an animated character to tell the software story using two human programmers, Edwin and Edwina as foils.

One of the major challenges was to explain the heart of the program, the algorithm. This turned out to be a flaw in the selection of World Traveler. The search for the shortest road path between two cities involved building up and walking through a tree structure. Jon and Nancy felt it was just not possible to sustain the general public's interest through an explanation of so abstract a concept. Instead, a smaller piece of the program was explained—how the identity of a city is determined from the location pointed at by the trackball.

The next step was to find someone to do the animation. Dean Winkler, a long-time Museum supporter and Vice President and Director of Creative Services at Post Perfect Inc., a special effects and production facility in New York City, was intrigued with the project. A week after Oliver re-established contact, Dean was at the Museum meeting with Palfreman and Linde to draw up a preliminary plan. Everyone was thrilled to know that there would be spectacular graphics and an extremely professional look to the theater.

The Information Machine

Richard Fowler, along with educators Natalie Rusk and Chip Morrison, felt that visitors needed an introduction to basic concepts before entering The Walk-Through Computer. They lobbied to build a set of educational interactive panels at the beginning of the exhibit. Gwen Bell cautioned against adding

non-budgeted items, but the educational arguments were compelling. Oliver and Chip determined that the goal of the introduction was to demonstrate how data in the form of numbers, text, sounds, or pictures, as well as instructions, were all different forms of information that could be converted into a pattern of binary digits. This would explain why the computer, an Information Machine, was so universal in its application. It was decided to design and build the "Information Machine" panels with our own carpenters, Tom Merrill and Don Greene, and to allow David Macaulay free rein in the graphics.

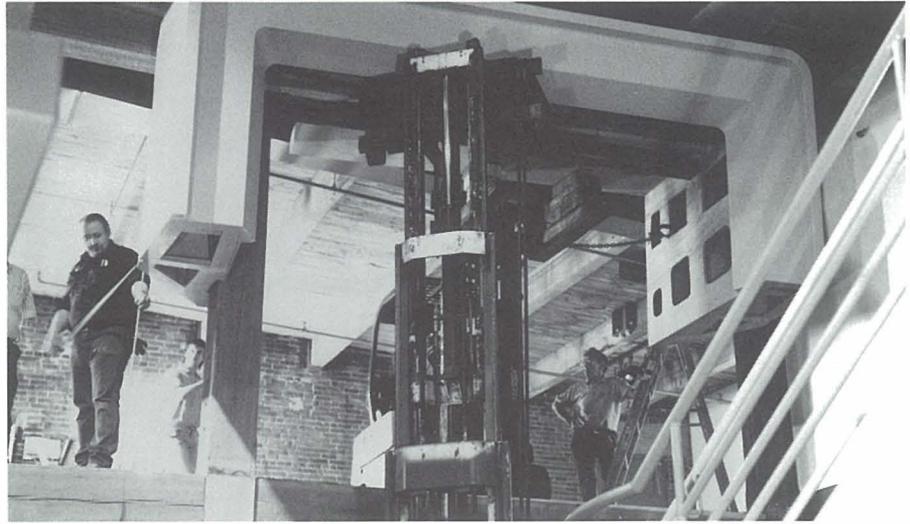
Mark Siegel, Richard's design assistant, took over the three-dimensional design for the interactive stations. Peter Miller, who had worked on the design of the motherboard, was assigned to create the hardware needed to drive the six interactive demonstrations. By early April, cardboard models were ready for Natalie to conduct formative evaluation. This resulted in many significant changes, many of them suggested by Museum interpreters or the public.

Building Components

F. W. Dixon, the main contractor, had scheduled completion for June 1, allowing three weeks for the installation of the lighting, video, and sound. But the 1:1 scale motherboard was late, and since Dixon was going to scale the 50:1 motherboard directly from it, the whole schedule started to slip.

By the end of March, the space was ready for installation. The SAGE exhibit had been removed and a hole had been cut in the brick wall on the fifth floor to connect the motherboard to the Software Theater. The 25-foot-long keyboard, the power supply unit, the trackball, the floppy disk, and giant monitor were largely complete at Dixon's workshop.

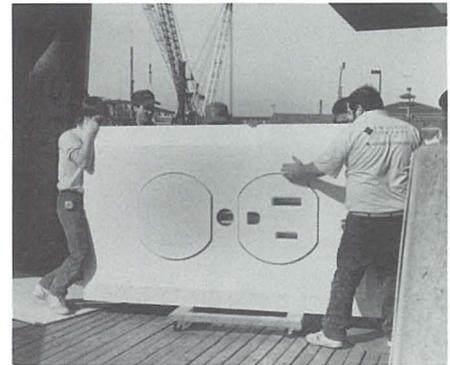
For many weeks, Dixon and Richard searched for a material that would simulate the translucent green plastic of a computer's printed circuit board and yet be durable enough to withstand the feet of many thousands of museum-goers. The ideal plastic subfloor with embedded neon tubing, covered by a transparent capping layer made of durable resin, had to be rejected when it proved impossible to find a glue that would bond the two layers together.



The monitor is installed in two pieces.



Dixon's workmen open up the brick wall.



The giant power plug outlet is delivered.

Reluctantly, the team conceded that visitors would have to be confined to walk on certain areas of the motherboard only, where the flooring would consist of a sturdy plain green linoleum to be imported from Germany. This flooring was strong enough to hold embedded strips of Tivoli floor lighting representing the data channels along the bus. The remainder of the motherboard would be raised, and would be made of translucent Lumacite which would be lit from below as well as with embedded Tivoli.

Funding closes

Throughout this period Oliver continued to raise money with additional funds coming from Kensington Microwave Ltd., Lotus Development Corporation, and Cirrus Logic. The total cash raised amounted to \$887,500.

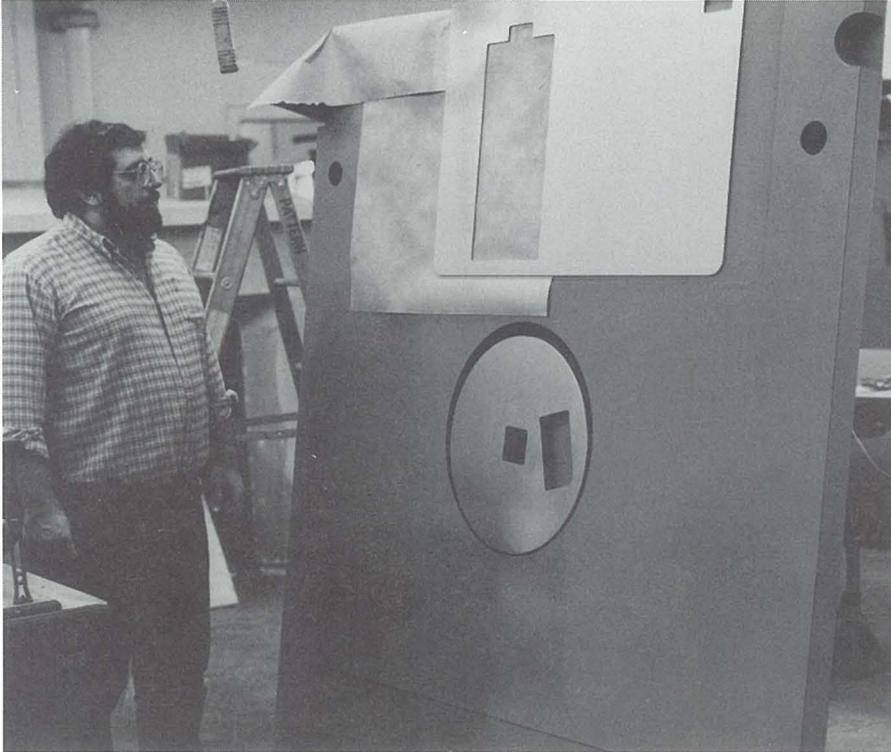
Implementation April 1-May 15, 1990

In early April, a five-man rigging crew from Dixon hoisted the computer's giant monitor into place on the sixth floor. A team of Dixon workers then set up shop in the gallery and quickly installed the keyboard, front chassis wall, and power supply.

Chip, Oliver, and Natalie continued writing the script for the panels. It was an exacting task, and the text passed through many cycles of editing.

World Traveler

By this time, David Greschler had a prototype of World Traveler running for North America. Extending the program to the remaining continents involved looking up and entering a great deal of data on city locations and road connections. Dan desperately needed David to help with the



At Dixon's workshop, Project Manager George Vanikiotis, Jr., puts finishing touches on the floppy disk.



Natalie Rusk worked with students to find out what they wanted to know about computers.

viewport animations so several excellent volunteers were recruited: Ellie Kerns from Waltham, Mass., did Africa, Pamela Bugg from Boulder, Colorado, did Asia, while Museum Interpreters Tim Granlund and Norman Simpson took care of Europe, Oceania, the Middle and Far East, and Central and South America.

Animating the Viewports

The team decided to create six different viewports: two views of RAM, one each for the CPU, the hard disk, the video board's digital-to-analog converter, and the video memory. Each viewport showed the functional view synchronized to simulate the execution of World Traveler slowed down tenfold. At this speed, a visitor could comfortably watch the execution of a complete cycle of the World Traveler. The scanning electron microscope silicon view filled inactive, dull phases of the cycle.

Altogether 90 minutes of computer animation were made using MacroMind Director on the Museum's Macintoshes with the help of SuperMac's color monitors and accelerators. This was a formidable amount of work, and was completed by Dan Griscom and David Greschler in just six weeks.

Lighting Effects

Each animated instruction in the viewports actually represented thousands of machine-level instructions. Each data object represented entire images or sounds consisting of thousands of bits. Thus each step shown in the viewports corresponded to thousands of clock cycles. The flow of data would therefore have to be represented impressionistically, with wires lighting up during periods of communication between the various components.

Alan Symonds explored neon lighting, edge-lit plexiglas, Tivoli, and other systems. In the end, with the delay in the specification of the motherboard, the decision to use Tivoli was more or less forced onto the team. It was flexible, available, and used safe low voltage. However, this choice sacrificed the ability to show directionality of flow; the entire wire would have to light simultaneously.

Installation: May 15-June 6, 1990

Time was running out, but the team refused to cut corners, choosing instead to work late into the night. Oliver added extra helpers to the team and strove to keep morale high during the stressful weeks leading up to the opening.

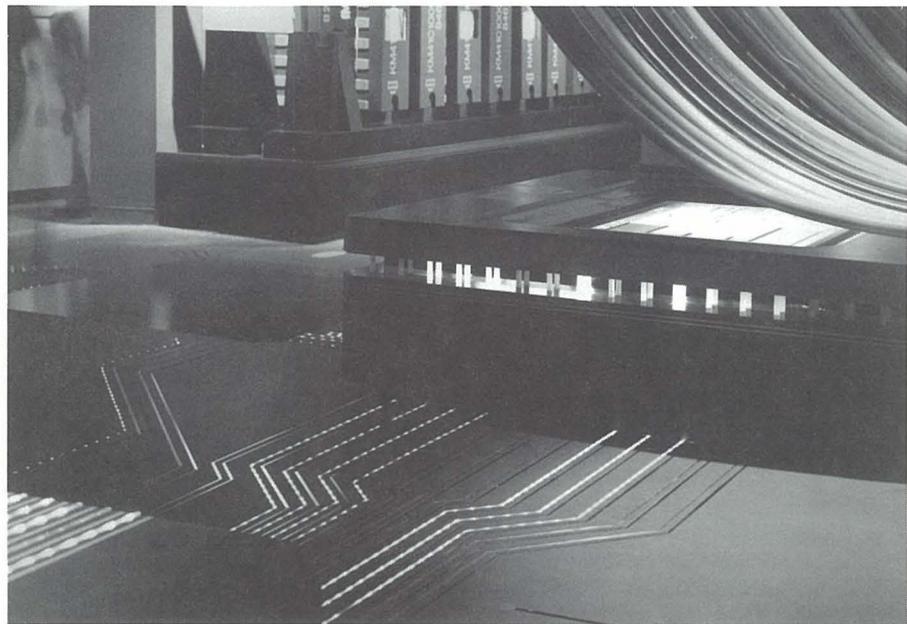
In late May, the exhibit text panels were still being reviewed by school children and educators. Then, starting June 1, Ted Groves, a new addition to the staff as graphic designer, integrated the text and David Macaulay's illustrations to create the final panel art. Batches of panels were sent out to be silk-screened. After many long days and nights on the Macintoshes, Dan and David completed the 90 minutes of animation for the viewports. Dan decamped to Post Perfect in New York for a week of all-night sessions to convert the Macintosh animation into video, perform on-line editing, and press the video disks.

Meanwhile, Dixon's crew was falling behind schedule. Extra carpenters were hired to build the Software Theater walls and seating. George Vanikiotis conceded that his Dixon crew would probably be there until the last minute. The team would not have the luxury of installing the electronics, lighting, and video equipment after construction had been completely finished; everyone would have to work simultaneously.

Alan's workers grew in numbers. He learned that theater lighting specialist Gayle Jeffery was between off-Broadway engagements, and she joined the crew along with David Ammar and Adam Kibbe. As soon as the decision was made to use Tivoli for the motherboard lighting, electronics engineer Michael Callahan started a production line for the 20 controller boxes needed to drive the 338 lighting instruments that included 2,000 feet of Tivoli lighting, almost half a mile of ribbon cable, and 208 pins for the CPU and UART chips. All this lighting inside the giant computer was controlled by a real computer—a MicroVAX 3400 System, donated by Digital Equipment Corporation, using custom software running under the VMS operating system. A scripting language specially written for the exhibit by software engineer David Fagan let Alan set up a cueing script for the many special effects devices using a set of simple, flexible commands. This enabled him to tune the lighting for the best effect.



A Dixon workman routs out grooves to accommodate the lights representing bus wires.



Tivoli lighting was selected to represent connections between components on the motherboard.

Meanwhile, the Software Theater production was in full swing, with a team of animators working at Post Perfect to create the artificial eyes that were to represent the video's narrator. A set was created in the Museum's auditorium to film Edwin and Edwina acting the roles of the World Traveler's programmers. However, the script called for some filming in *The Walk-Through Computer* itself. With the schedule slipping, the exhibit would be complete just days

before the opening. Nancy and Jon were used to tight production schedules, and planned a shoot for the Sunday before the Thursday opening, allowing just three days for off-line and on-line editing and disk pressing.



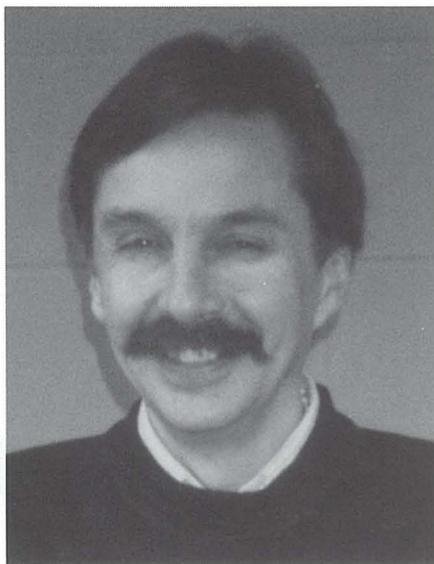
Nancy Linde, Assistant Video Producer

By Monday, June 4, the work in the motherboard area blocked visitor access to the personal computer and graphics galleries. Visitors were re-routed down the back fire stairs to reach the rest of the Museum.

Peter Miller had completed the motherboard electronics and was devoting his time to developing the Information Machine stations. His sonorous baritone earned him the role of The Walk-Through Computer's voice; he patiently pronounced hundreds of city names into a microphone for The Walk-Through Computer's real computer, the Macintosh IIx, to digitize and store. No one anticipated the research required to find the correct pronunciation of 400 city names from around the world. Fortunately, volunteer Pamela Bugg took on that task.

Julie Bingham, director of language products at Symantec Corporation, arranged for the donation of some computers for the Information Machine interactives, and some programming time, two items not in the budget.

The Learning Stations were progressing under the guidance of Chip. Volunteer Barry Kort, a visiting scientist at Bolt, Beranek, and Newman, answered a call for a Macromind Director expert and spent hundreds of hours finishing the Learning Stations. Karyn Scott of VideoLogic managed to obtain donations



Jon Palfreman, Video Producer, Software Theater

of a computer, color monitor, and a videodisc player for the interactive video learning station on computer manufacture.

Completion: June 6-20, 1990

The countdown moved to days. Richard arrived at 5am with the Dixon crew, about the time that Alan Symonds and his team of theater people were breaking for a few hours rest. Every evening, twenty to forty employees and volunteers worked late, gathering around long tables for Chinese food or pizza.

With the cuing software complete, Alan moved the MicroVAX down into its room next to the motherboard and took up almost 24-hour residence in the gallery. Michael Callahan arrived with a truck full of controller boxes for the lighting, and then installed the audio system throughout the exhibit.

During this last week, the media hounded the Museum for previews. As the attention of major publications and television networks mounted, the public relations team could no longer resist their requests. Film crews were allowed to shoot, halting work for half hour periods here and there. Tension grew, but the team was also excited at this foretaste of the enormous exposure that was to come. *Newsweek* writer John Schwartz was so intrigued that he stayed for a whole day, while Natalie found some Lego to entertain his three-year-old daughter.

On Thursday, June 14, one week before the first opening party, Alan calculated that he and his crew were about a week behind; it looked as if they would be working round the clock!

The noise in the galleries was ear splitting, as the fabrication crew raced to finish routing the grooves for the Tivoli lighting in the motherboard flooring in time for the weekend volunteers. This lighting would run through the floor, recessed into the linoleum to simulate the bus and other connections between the computer's components. The installation of the Tivoli lighting was an exacting job for crews of about six volunteers at a time. First the plastic housings had to be cut to fit into the grooves that snaked across the motherboard. Next, fragile chains of lights had to be cut and threaded through the housings. Finally, each housing had to be glued into its proper place in the floor. Other volunteers painted and installed spotlights. Alan put Gordon Bell to work inside the hard disk, where the DC motor strainers to spin the large solid plywood platters. Meanwhile, up in the offices, a team was pressing on to complete the programming of the Learning Stations. It was a productive weekend.

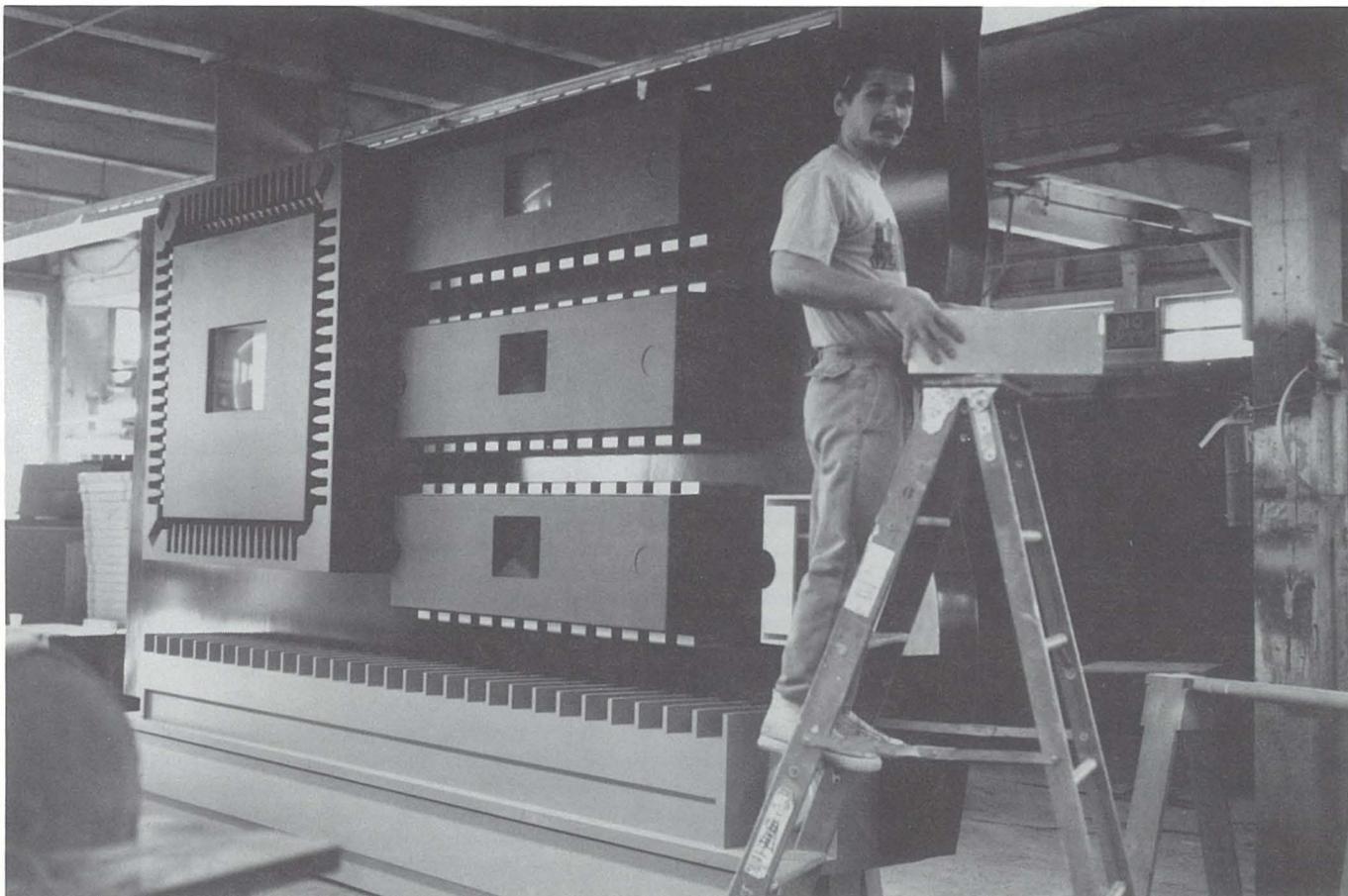
By Monday morning, Alan said that he had made up several days' work. Then, the trackball failed. Alan and Gayle Jeffery took it apart. It needed a better solder connection at a critical component; only two hours were lost.

With the Tivoli lights installed in the floor, the wiring could be completed to simulate the data movement along the bus, up the pins and into the CPU. Marketing Director Noel Ward, Gordon Bell and several other volunteers completed most of this wiring on Monday night.

By Tuesday morning, Peter had completed recording the voice of the World Traveler program.

Meanwhile, Tom Flotte, a pathologist at Massachusetts General, arrived at the Museum almost every other day with improved versions of a program for one of the Information Machine stations.

On Wednesday, the Software Theater film arrived and was tuned for its three-projector screen. The Learning Stations were installed. Everything was coming together.



The final push toward opening night.

Opening: June 21, 22, 23, 1990

On Thursday morning, at 4:30 am, after David had spent the night fine-tuning the World Traveler application, he found that when he tried to hook it up to the giant monitor, nothing happened. Fortunately, the NBC crew who appeared at 5am was planning to shoot inside the machine.

Oliver had arisen before 5am, to be ready on-camera for the *Today Show*. After working through the night, Alan and his crew had managed to get most of the Tivoli floor lights working. At 7:35am, just after the newscast, Oliver was interviewed live from New York as he sat on the CPU inside The Walk-Through Computer.

As soon as the NBC crew left, the workers came back in! By 9am, Dan Griscom had fixed a loose wire in the trackball, and the World Traveler program showed up on the screen. The team had eight

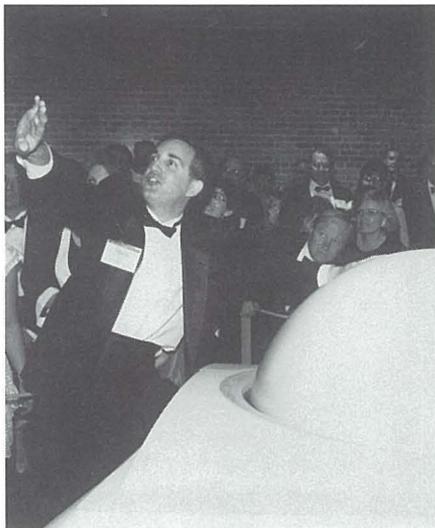
hours to finish. By now most of the Tivoli was running, all the viewports were on, the slowed-down sound on the motherboard was working and the hard disk was spinning. At 6pm, everything was shut down to await the official opening at 7pm. Moments later the first guests gathered excitedly around the outside of the giant computer.

Finally, at 7pm, the time had come. Gardner Hendrie, Chairman of the Board, Mitchell Kapor, the principal sponsor, and Oliver Strimpel, the project's originator, opened the exhibit with speeches and a demonstration.

In his remarks, Gardner Hendrie said, "The Walk-Through Computer fits the Museum's educational mission perfectly, as it provides a truly accessible introduction to computer technology."

Mitchell Kapor pointed out the special significance of this innovative educational exhibit at a time of crisis in the nation's educational system. Then Oliver Strimpel commented wryly that while the rest of the world had spent 40 years making computers smaller, faster, and cheaper, The Computer Museum had spent one year building one of the world's largest, slowest, and most costly computers!

Then came the moment everyone was waiting for. With Oliver providing commentary, Gardner switched the power on and, within seconds, World Traveler's spinning globe appeared. Gardner then selected and pushed the North American function key. Mitchell rolled the trackball to start a journey in San Francisco and end it in Boston. Sure enough, the giant screen showed the computer searching for the shortest route, finding it, and then showing pictures of the cities seen en-route to Boston to the accompaniment of Peter Miller's sonorous digitized voice.



Mitchell Kapor is the first to put World Traveler through its paces.



Friends from Intel Corporation join Oliver Strimpel to look at the giant CPU. From left to right: Dennis Carter, General Manager, End User Components Division; Lisa Dreske, Marketing Communications, Sales Promotions Manager; Kevin Teixeira, Marketing Communications Program Manager; Oliver Strimpel; Clif Purkiser, Corporate Development Manager, EUCD; Ann Lewnes, MIS Programs Manager; Jim Jarrett, Vice President of Corporate Communications.

The Walk-Through Computer was up and running before a rapt audience of sponsors and Museum Board Members.

But one significant problem emerged in the Software Theater. While the video was a splendid production, the World Traveler's programmers Edwin and Edwina had been cast as caricatures of eccentric programmers. Many guests, including the educators on the Advisory Committee, felt strongly that this was not the way to portray programmers for the next generation.

Friday, June 22

The crew went back to work first thing in the morning! For one thing, the start-up procedure had not yet been simplified, and Alan was the only person who could boot up The Walk-Through Computer lights and video. More work was also needed to mount pieces of the Macaulay graphics on the Information Machine panels.

That morning, at the Museum's Annual Meeting, the Board of Directors and Trustees enthusiastically applauded the work of the staff. On Friday night, Oliver led further opening ceremonies, this time for Museum members, friends, and workers on the project.

Saturday, June 23

At 10am on Saturday morning, there was a line of visitors at the door for the exhibit's public opening! The first people into the exhibit were Dora Ullian, of Newton, Mass., her son Ben, 4, and niece Jessica Nutick, 24.

Jan Del Sesto was duty officer and sat at the front desk all day, helping our front desk staff as they got used to handling 1,000 people a day, an event that was to become routine over the summer.

Aftermath: June 24 to July 4

Oliver went home and collapsed ... but he couldn't sleep. What was he going to do about the Software Theater! The following day he closed the theater down; later in the week, he decided to recast Edwin and Edwina but keep the same script.

Richard left for England on Sunday, just two days after the exhibit opened, ending an exciting and highly productive 13-month stay. On Monday morning, everyone else came in to assess the situation and compile the punch list of items that needed modification and completion. The intense pace of work continued until the Fourth of July weekend, when almost everyone took a break.

Final Completion: July

The main items on the punch list were completed. The start-up procedure was simplified to the throwing of a single switch. The last signs were installed. The Walk-Through Computer began to seem like part of the Museum.

Meanwhile, the Museum experienced record attendance, with 25,000 visitors for the month of July, an increase of 75% over the previous year's figures. It looked as if all the effort had really been worth it.

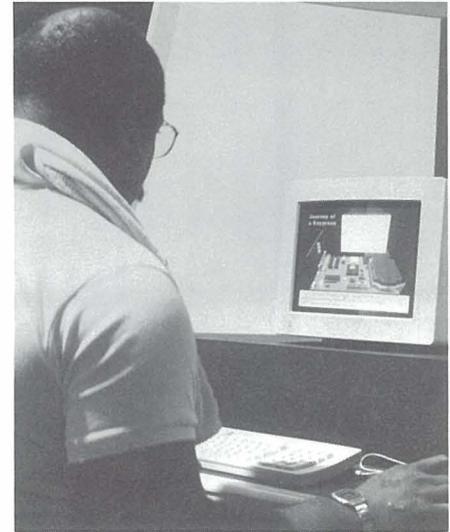
Training: August-September

By August, the revised Software Theater was operational, the exhibit development and Dixon crews had left, and the Museum was filled with people and a dramatic new exhibit.

Observation of visitors made it clear that many needed some help in order to derive the maximum benefit from the exhibit. Natalie Rusk, Dan Griscom, and others developed an explanatory guided tour. For school groups, a parts search was instituted, in which students become detectives trying to match actual components with the giant ones in the exhibit. For the general public, regular tours were started on busy days, and the interpreters were coached on how to help visitors at other times.



Oliver Strimpel (third from left) explains how the disk drive was built to supporters from Digital Equipment Corporation. From left to right: Lewis Karabatsos, Corporate Community Relations Communications Manager; Rose Ann Giordano, Vice President, U.S. Marketing; Nancy Dube, Manager, Corporate Community Relations; Grant Saviers, Vice President, PC Systems and Peripherals; Dorrit Saviers.



Visitor Leland Brown explores the "Journey of a Keypress" learning station.

National Outreach: October-December

In the spring, the Museum received funding from the Intel Corporation Foundation to produce a video based on the exhibit. Aimed at middle school students, the video would increase the educational impact of The Walk-Through Computer to an audience of millions. Entitled *HOW COMPUTERS WORK: A Journey Into The Walk-Through Computer*, the video was introduced in November.

Upgrades: 1991-1992

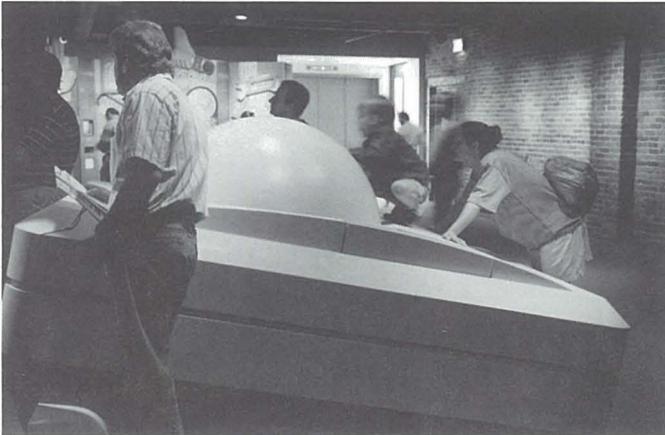
As technology progresses, the Museum will enhance the exhibit. One of the earliest upgrades will be better color. Although hardware donations were received for 24-bit color, Supercard, the program used to drive the application, only accepts 8-bit color. This limits the pictures of cities shown on the big screen to 256 colors, imposing a severe restriction on their clarity.

Many visitors seem confused by the giant components on the motherboard which are unlabeled, such as resistors and capacitors. A potential remedy is to name each component. Keeping the world map updated will require constant attention; fortunately, David was at the Museum the week that Germany was unified and he was able to unify the country on the World Traveler map! Changes such as these will continue to improve the exhibit.

Enhancing the Exhibit: 1992-1995

The Walk-Through Computer's specifications—the 486 micro-processor, 16 megabytes of RAM, and an eight-platter hard disk drive—should keep it "current" for several years. But optical discs, CD ROMs, and other technologies will soon prevail. While The Walk-Through Computer's architecture will not change, new components could be inserted to keep it up-to-date. A new application program could be written, and corresponding animation generated for the viewports.

In 1976, few people foresaw the significance that the personal computer would have a mere five years later. Is our vision of 1995 any clearer? Surprises that lie around the corner will affect the lifetime of the exhibit. How long can the exhibit live with upgrades? When will the Museum's mission to explain the technology of computing need an entirely new approach? Time will tell.



Museum visitors enjoy the giant trackball (above) and the interactive Information Machine panels (below).



*An interpreter gives a tour of *The Walk-Through Computer*.*

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VideoLogic, Inc.

The Walk-Through Computer Team

Exhibit Staff:

Dr. Oliver Strimpel, *Project Director*; Richard Fowler, *Designer*; Donald Morrison, *Exhibit Developer*; Alan Symonds, *Technical Director*; Dan Griscom, *Technical Consultant*; Peter Miller, *Electrical Engineer*; Mark Siegel, *Assistant Designer*; David Greschler, *Programmer*; David Fagan, *Programmer*.

Contractors:

F. W. Dixon Company, *Fabricator*; David Macaulay, *Illustrator*; Ruth Murray, *Assistant Illustrator*; Jon Palfreman, *Video Producer* (Software Theater); Nancy Linde, *Assistant Video Producer* (Software Theater); Michael Callahan, *Sound and Video Consultant*; Jane Cuthbertson and Ted Groves, *Graphic Designers*.

Special Consultants:

Animators: Drew Huffman (*Paracomp*), Dean Winkler (*Post Perfect*); *Project Consultants:* Tony Fernandes (*Lotus Development Corporation*), Mitchel Resnick (MIT); *Programmer:* Tom Flotte (Mass. General Hospital); *Engineers:* Joe Siegal (*Digital Equipment Corporation*), Len Dougherty (*Digital Equipment Corporation*); *Researcher:* Marcia Cohen (*Bingham, Dana, and Gould*).

The Advisory Committee

Art Bardige, Director, Learningways; C. Gordon Bell, Chief Scientist, Stardent Computer Inc.; Daniel C. Dennett, Professor of Cognitive Science, Tufts University; Allison Druin, Tell Tale Technologies; Signe Hanson, Director of Exhibit Design, Boston Children's Museum; Gardner Hendrie, Sigma Partners, Chairman of the Exhibits Committee; Danny Hillis, Founding Scientist and Director of Research, Thinking Machines; David Macaulay, author and illustrator; Philip Morrison, MIT Institute Professor; Phylis Morrison, curriculum developer and producer of science materials and programs; David Patterson, Professor of Computer Science, University of California (Berkeley); Jonathan Rotenberg, founder and Chairman, The Boston Computer Society; Richard Rubenstein, Manager of Technology Assessment, Digital Equipment Corporation. Museum staff: Oliver Strimpel, Executive Director; Adeline Naiman, Education Director; Michael Chertok, Education Coordinator; Dan Griscom, Exhibits Engineer; Gwen Bell, Founding President, and Chip Morrison, Exhibit Developer.

In 1990, the collection spaces of the Museum were reorganized and a survey of the conditions was undertaken with support from a conservation grant from the Institute for Museum Services. As a result, all the collection spaces are being monitored with recording hygrothermographs and are maintained within acceptable temperature and humidity parameters. In addition, acid-free boxes have been acquired for the storage of the document collection.

The permanent collection currently numbers 1,049 artifacts. This year only 37 artifacts were accepted out of a total of 300 considered. In contrast, the document, photograph, and film and video collections are growing rapidly. This change can be attributed to the primary sources of the different collections. Most computer artifacts are offered to the Museum when they are decommissioned from use by a corporation or institution. Ten years ago, when the Museum started collecting, some vacuum tube and transistor machines were still being decommissioned. Today, with much greater standardization, fewer machines are being decommissioned that fit the criteria for acceptance into the collection—that they are the first, the classic, or a special example.

In contrast, most documents and photographs are acquired from individuals who are moving or retiring—or from their heirs. Again, ten years ago, many of the pioneers were still going strong. Now, sadly, we have the task of accepting materials from relatives of people who have died. While we accepted ten boxes of early material from Alan Perlis' office at Yale, we were also able to supply Sydelle Perlis with several videotapes of Alan in action.

The increasing rate of accession of film and especially videotape has occurred since film and video are a growing and valuable record of the wide-ranging applications of computing. In particular, the Museum has collaborated with PBS's Boston affiliate WGBH-TV in a search for material for their six-part television series *The Information Age*. We expect the film and video collection will grow dramatically in the future, preserving an active record of the people, settings, and machines which make up the history of computing.



"The fundamental idea behind the three-dimensional display is to present the user with a perspective image which changes as he moves," Ivan Sutherland wrote. "The image presented by the three-dimensional display must change in exactly the way that the image of a real object would change for similar motions of the user's head."

New Acquisitions Highlights

Sutherland's Experimental Vision System
Beginning in 1966, with funding from ARPA and the Office of Naval Research, Ivan Sutherland led efforts to create computer-generated, interactive, three-dimensional visual environments. By 1970 a simulated or "virtual" environment had been realized using a helmet, which incorporated a pair of small CRTs, projecting images through mirrors to the user's eyes. The helmet was attached to a large device known as the "Sword of

Damocles" which hung from the ceiling and tracked movements of the user's head. Innovative hardware and software generated images consistent with the movement of the user.

WISC

In the early 1950s, Gene Amdahl, a PhD student in physics at the University of Wisconsin, undertook to build a computer for his doctoral dissertation. The WISC (Wisconsin Integrally Synchronized Computer) project, supported by the Wisconsin Alumni Research Foundation and the University of Wisconsin College of Engineering, was completed in 1953. Only a handful of computers existed when WISC was proposed, and during the late 1940s and early 1950s many universities and laboratories went ahead and built their own machines.

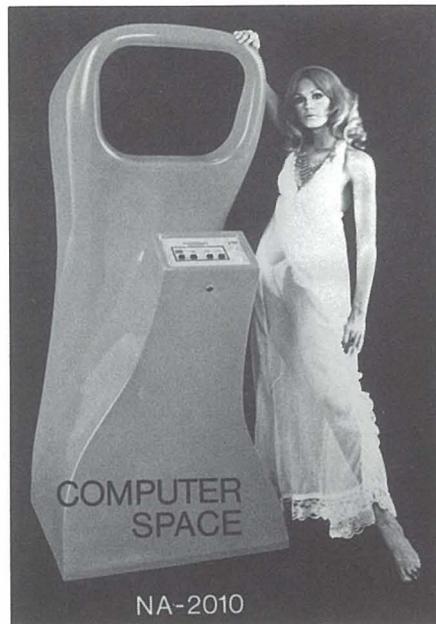
The WISC design was governed by requirements for ease of construction and simplicity of operation. WISC was a small machine with a long word length (50 binary digits) and floating point arithmetic. It incorporated 1,800 vacuum tubes and 350 diodes. The storage system was a 1,024 word magnetic drum. The name WISC is derived from the computer's ability to carry out four instructions simultaneously (integral synchronization) resulting in efficient use of the slow access time of the drum. A flexowriter and paper tape were used for input/output.

After Amdahl graduated and went to IBM Corporation, the WISC was used at the University of Wisconsin's Department of Electrical Engineering. Graduate students and faculty used the computer for both engineering and scientific computation, modelling, and training.

WISC was decommissioned in the early 1960s and the machine's sole maintenance engineer stored the entire computer in his basement for years. Eventually, realizing that he was sitting on a piece of history, he called Amdahl Corporation, the firm Amdahl had started after leaving IBM, and spoke with a Vice President of Sales, who arranged for one of the firm's trucks to pick up the computer from the engineer's house. Amdahl Corporation staff set WISC up on the loading dock and surprised Gene by presenting him with his own computer. In 1990, Gene gave WISC to The Computer Museum.

The donation to the Museum consists of the console, the CPU and power supply cabinets, a full set of diagrams, and documents relating to the construction of the machine. The presence of bills from suppliers like HeathKit indicate that this was a small project, run by a single person operating with a small budget and with little bureaucratic interference. For example, the handles on the console doors are the kind that one would buy in a hardware store for use on kitchen cabinets.

Amdahl gave a talk on the early days of computing at The Computer Museum in 1983 as part of the Museum's Pioneers of Computing lecture series. Preserved on videotape in the Museum archives, his lecture captures a physicist's struggle to build a revolutionary new tool.



*Computer Space, 1971
First commercial coin-operated video game*



*Cray 1M/4400, 1976
Supercomputer with power of Cray 1
in smaller package*

Artifact Collection

The 37 artifacts collected in 1990 represent some extremely important additions to the Museum's collections. The Collections Department was surprised to have found that the Museum had not collected the classic IBM PC announced in 1981. Now it is not only in the collection but on display. Similarly, the Museum acquired a Cray 1M for the collection and for the exhibit of Four Classic Computers.

In the future, the Museum hopes to place more emphasis on collecting some non-US machines so its holdings from Germany, Japan, France, England, and other countries will be more representative. In addition, the Museum will continue to pursue the survivors from previous generations.

Computers

Cray Research, Inc.

Cray 1M/4400, 1976

Supercomputer with power of Cray 1 in smaller package

Gift of Cray Research, X1043.90

ETA

ETA 10, 1988

Innovative supercomputer with the fastest vector performance of the time

Gift of ETA, X1041.90

International Business Machines Corporation
PC, 1981

Classic 256K personal computer

Gift of Harvard Business School, X1039.90

Northstar

Horizon, serial number 1,1979

First personal computer sold with integrated mini-floppy disc drive. This machine was purchased by the father of the founder of the company.

Gift of Gene Grant, X1033.90

University of Wisconsin

WISC (Wisconsin Integrally Synchronized Computer), 1953

Gift of Gene Amdahl, X1040.90

Sub-assemblies and components

General Electric Company

Vacuum tube-based flip-flop, 1948

One stage of a shift register for special purpose digital radar-tracking machine

Gift of Gene Grant, X1024.90

Austek Microsystems, Ltd.

A38152

First cache controller on a microprocessor board

Gift of Craig Mudge, X1035.90

Intel Corporation

4004 - 1971

8008 - 1972

8080 - 1974

8086 - 1978

8088 - 1979

80286 - 1982

80386 - 1985

80386SX - 1988

80486 - 1989

Series of microprocessors that have become industry standards

Gift of Intel Corporation, X1036.90

Massachusetts Institute of Technology

Whirlwind I modular components

Flip-flop storage registers

Gift of Brian White, X1031.90

Texas Instruments

960A, 1971

Computer and communications multiplexor for up to 256 terminals

Gift of Texas Instruments Corporation, X1027.90

Transducers

Bell Laboratories

Graphics 1, 1965

Graphics console used in development of remote, time-shared system

Gift of University of Florida, X1029.90

Paradyne Corporation

MP 48 model 2448 modem, 1978

First microprocessor-controlled modem

Gift of Colin Povey, X1014.90

Ivan Sutherland

Experimental vision system

Gift of Ivan Sutherland, X1044.90

Tarbell

Tarbell cassette interface rev. C model 1001, 1975

Kit cassette interface board, cables, and software

Anonymous gift, X1023.90

Univac Division, Sperry Rand Corp.

Uniscop 300, 1967

Programmable visual display communication terminal

Gift of Unisys Corp, X1047.90

Univac Division, Sperry Rand Corp.

Uniset, 1961

Airline reservation terminal

Gift of Unisys Corp, X1048.90

Memories

National Cash Register, Inc.

CRAM film, ca. 1960

Film memory medium in portable cartridge

Gift of Dr. Carl Hammer, X1030.90

Univac Division, Sperry Rand Corp.

FH400, 1959

Flying head magnetic drum

Gift of Unisys Corp, X1049.90

Wang Laboratories Inc.

Core memory board, 1967

Magnetic core supplemental random-access memory

for Wang calculator

Gift of Richard Rubinstein, X1018.89

Microprocessor-based devices

Compucomp

Compucomp

Programmable calculator

Gift of David L. Pelz, X1026.90

Nutting Associates

Computer Space, 1971

First commercial coin-operated video game

Gift of Alan Rifkin, X1025.90

Card Data Processing Equipment

Remington-Rand

Multi-control Reproducing punch, 1948
card punch

Gift of Unisys Corp., X1045.90

Remington-Rand

Counting sorter, 1948

card sorter

Gift of Unisys Corp., X1046.90

Slide Rules

John E. Fuller

Fuller's Computing Telegraph, 1865

Specialized circular slide rule for the grain exchange

Gift of The Cobb Family, X1038.90

Robots

Stanley Reifel

Sherbot, 1978

Home-built robot controlled by a Polymorphic Systems microprocessor.

Gift of Stanley Reifel, X1037.90

Other

Hickok

Model 539C, 1970

Industrial and laboratory portable tube tester
Gift of Brian Saper, X1032.90

H.P. Peterson

"Mona by the Numbers", 1965

Computer graphic line-printer portrait

Gift of Henry S. Forrest, X1028.90

Unknown manufacturer

Paper tape splice jig and other paper tape handling materials, ca. 1960

Gift of Bruce Cardin, X1034.90

Indecks Company

Research device, 1968

Card based storage and retrieval system

Anonymous donor, X1042.90

Study Collection

The study collection is administered and stored separately from the artifact collection. The items in this collection are used for educational, exhibit, and research purposes. They often duplicate items in the artifact collection.

Atari

PONG game case

Gift of Alan Rifkin, S#78

Milton Bradley Electronics

Electronic Grand-Master computerized chess game

Gift of Howard Cannon, S#79

David G. Hammel

Remote transaction system patent prototype

Gift of the family of David G. Hammel, S#80

Wright Line

Model 2600 manual card punch

Gift of University of Massachusetts, S#81

International Memories Incorporated

Model 7720 hard disk drive

Gift of Applied Management Systems Incorporated, S#82

Honeywell, Honeywell Bull, and General Electric Corporation

Collection of printer and reader heads, including

Braille read and print heads

Gift of J. G. Bunner, S#83

Facsimiles of punched cards for the Hollerith

Electronic Tabulating Machine

Gift of Professor Owen Gingerich, S#84

Collection of punched cards for programming and business use

Gift of John J. McCaffrey, S#85

Slide rules and drawing instruments from the

collection of Dr. Carl Hammer

Gift of Dr. Carl Hammer, S#86

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The West Coast Team won The Second Annual Computer Bowl, April 27, 1990. From the left: P.C. Letter Editor-Publisher Stewart Alsop II, Microsoft Corp. Chairman Bill Gates, venture capitalist John Doerr, Chuck House, of Hewlett-Packard, and Larry Tesler, of Apple Computer, Inc.

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