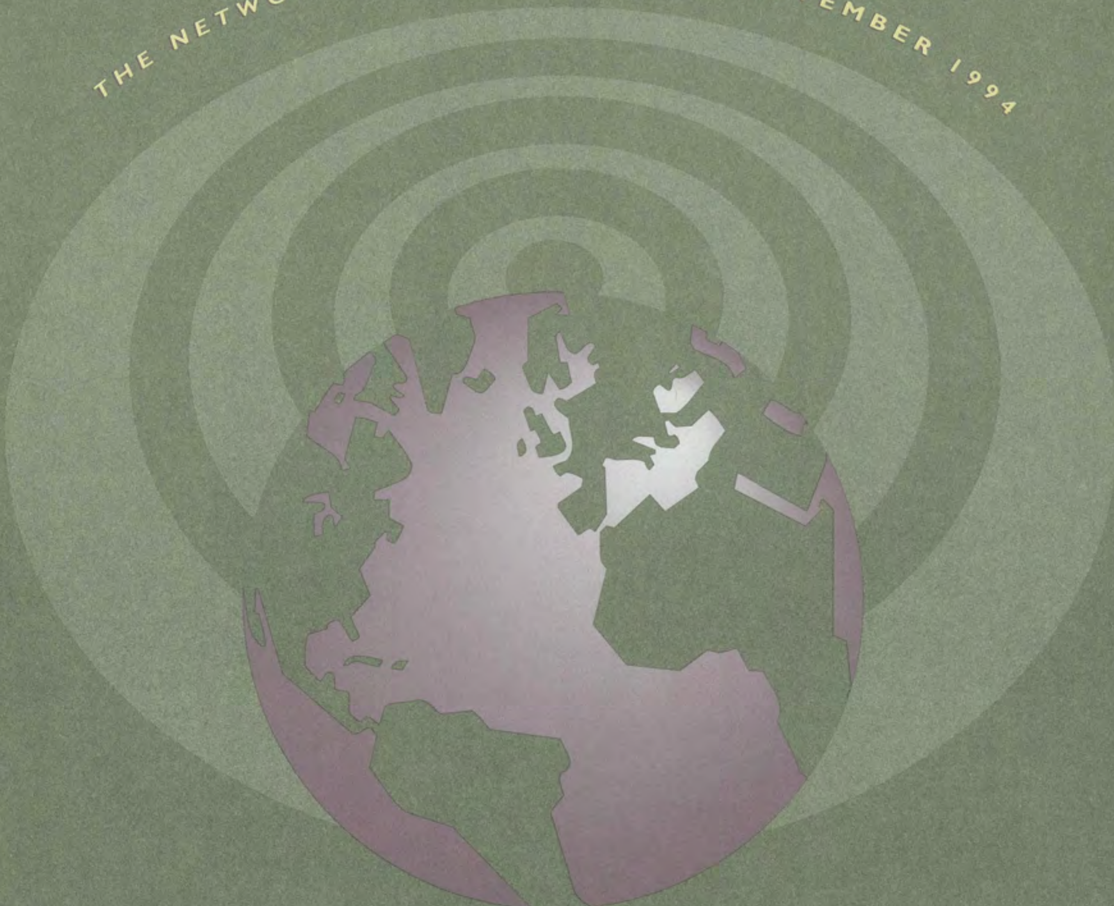
# THE COMPUTER MUSEUM

THE NETWORKED PLANET OPENED NOVEMBER 1994



Annual Report FY'95

# Expanding Our Horizons

Looking back on a year rich with accomplishment, one theme in particular strikes me — that of the Museum expanding its reach, in distinct but interconnected ways.

First, the Museum extended itself beyond its usual domain of superbly crafted interactive exhibits by surprising — and delighting — visitors with two exhibits on computers and art. Witness our highly successful *Robotic Artist: AARON in Living Color* exhibit, as well as our collaboration with the DeCordova Museum in Lincoln, Mass., on *The Computer in the Studio* art show.

Second, with the launch of *The Networked Planet*™ exhibit, we welcomed telecommunications corporations to our family of supporters. The exhibit, which reflects the close relationship of computing and communications, continues to attract a steady stream of visitors eager to learn about networks.

Similarly, *The Networked Planet* drew on support and conceptual development from the international corporate community. While physically in Boston, the Museum is now truly without global boundaries in its friendships. (And we shall work hard to make these borders vanish even further in the coming year, as we leave an ever-larger Museum imprint in cyberspace!)

None of this could happen without the most generous help of the Museum's many supporters. On behalf of our entire Board, I offer heartfelt thanks to you all.

**Charles A. Zraket**
Chairman of the Board of Trustees

Photograph: David Bohl

# THE YEAR OF THE INTERNET

The Computer Museum launched itself into "cyberspace" this year, chronicling and exploiting the surge of global networking that is taking the world by storm. In November, we opened *The Networked Planet,*™ a major permanent exhibition on global networks that takes the mystique out of "The Information Highway" by revealing the technology and social effects of telephone, financial, transportation, weather, retail, and medical networks, as well as the Internet. In an extraordinary collaboration with our sponsors, the Museum was able to offer visitors high-bandwidth connections to the Internet, providing one of the first public-access sites to the World Wide Web. This issue's cover story describes the project in detail.

The Museum's T1 link to the Internet not only enabled visitors at the Museum to "surf" the Web, but also, for the first time, opened up the Museum to remote visitors from around the world. Our Web site, <http://www.tcm.org/>, went live in January, offering the Internet Sampler, the first example of an interactive exhibit to become available to remote users. The site also features over 100 pages of information about the Museum, including this issue of The Computer Museum *Annual.*


This screen capture shows the home page of the Museum's current Web site.

The Computer Clubhouse, the Museum's open-ended exploration space for inner-city 10- to 15-year-olds, is also an online leader. Demonstrations of the kids' skill can be seen in the ever-changing online art show, <http://www.tcm.org/clubhouse/projects/gallery/>, also featured at SIGGRAPH 95.

A two-year grant from the National Science Foundation is enabling the Museum to explore the wider possibilities of an Online Computer Museum (OLCM) to make exhibition and collections resources available to anyone with Internet access. At a March workshop, experts from industry, academia, and the media developed guidelines for the OLCM. Three primary uses were foreseen. First, the OLCM can provide a surrogate visit, especially for people unable to get to the Museum in person. But it was recognized that in order to be effective, exhibition materials will require "re-curating" for the online medium. Second, the OLCM can help prospective visitors plan a visit to the onsite museum, serving as a customized "electronic brochure." Third, the OLCM can offer an in-depth view of collections and exhibitions that goes beyond the material available in the onsite gallery. Students and researchers will likely value this.

The Museum's ever-popular benefit, The Computer Bowl,® also ventured into cyberspace last year with each coast's team remaining on their home turf, responding in real time to questions from the questioner in "Virtual Kansas." (See page 18.) And, in partnership with ONSALE Interactive Marketplace, the Museum conducted one of the first-ever charity auctions on the Web. The sale of 134 items garnered world-wide exposure for the donors and offered bidders from around the world a unique and entertaining experience. The excitement of the auction room was recreated online, with the server taking over 10,000 hits per hour as the close of bidding approached.

Artifacts, consisting as they do of atoms rather than bits, cannot be placed online. But, increasingly, the Museum's collections will feature bits: images, documentation, film and video, and software, all of which can be stored and disseminated online. The first item to be placed online in this way is the archive of the MsgGroup, one of the first ARPAnet mailing lists, which, between 1978 and 1986, addressed almost every issue regarding the design and use of electronic mail. The Museum also started an occasional e-mail letter for the international community interested in the collections.

Find Images Open Print Reload

This year the Museum took advantage of the Net to augment informal and frequent communication with its community of members and supporters and to perform administrative tasks such as renewing memberships and booking functions. The Museum's volunteer boards and committees that span the world are now connected instantaneously via electronic mail. And job candidates have competed successfully for staff positions that were posted online.

While these forays into cyberspace were taking place, the Museum had its best-ever onsite year with a record number of visitors in the flesh. The big draws were *The Networked Planet* and, in April, a quintessentially onsite exhibition of Harold Cohen's color painting machine. This one-of-a-kind installation was a tour de force of art, artificial intelligence, and robotics. Featured live on both the *Today Show* and *CBS This Morning*, *AARON* captured the imagination of kids and adults alike. (See article on page 10.)

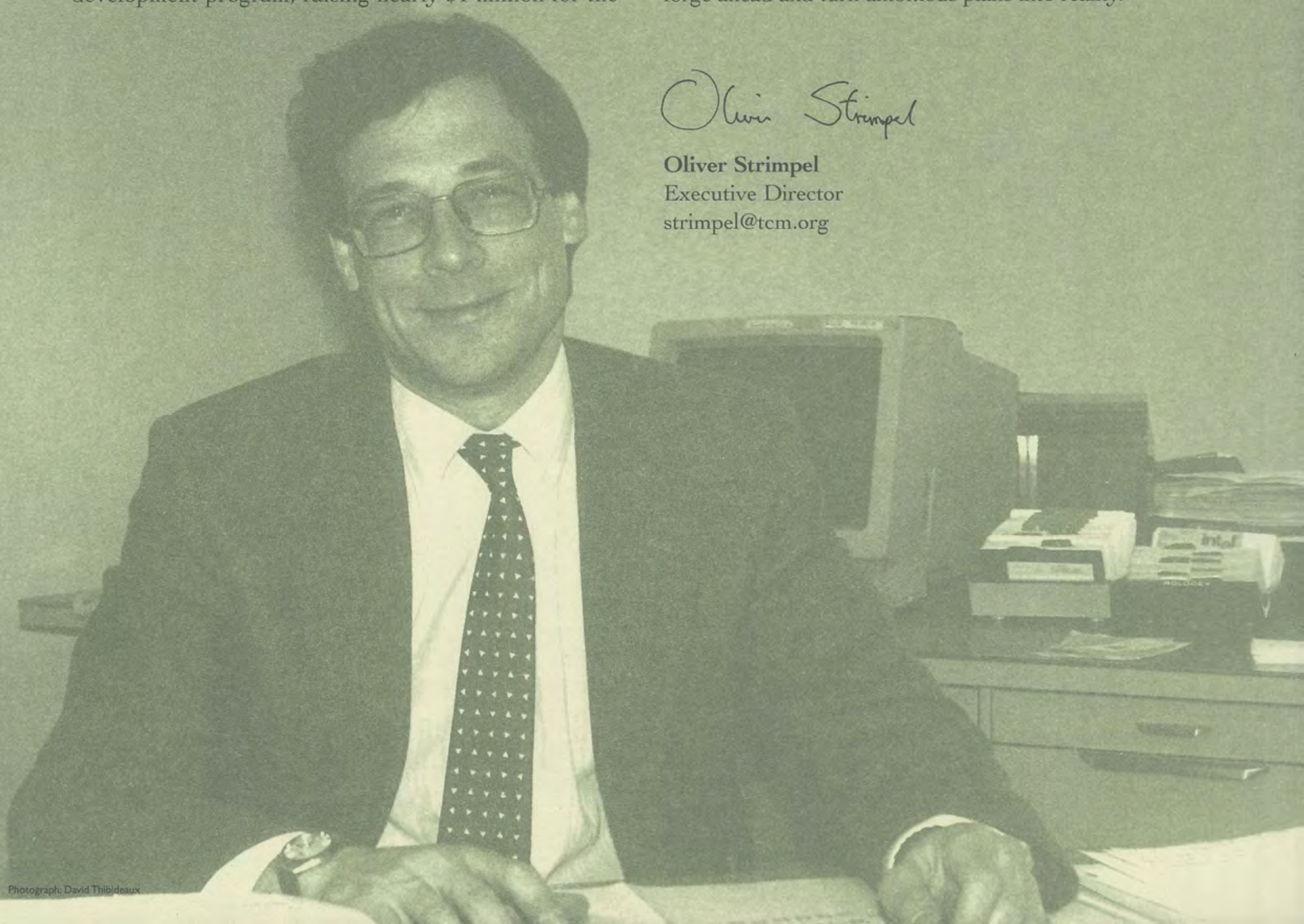
This year the Museum maintained its fast-paced exhibit development program, raising nearly $1 million for the all-new *Walk-Through Computer*™ *2000*. During the year, we completed the exhibit's planning, posting concept sketches on the Web site (see <http://www.tcm.org/tcm/uc/>). The strong support of industry leaders in Silicon Valley, especially principal sponsors Cirrus Logic and Intel, has been critical to the success of this unique educational project.

It is very gratifying to report that the ranks of Museum supporters grew last year: Thirty-seven corporations joined the Museum as new members, and the Friends, the group of the Museum's $1000/year-and-above supporters, grew to 74 individuals. Your generous contributions, both intellectually and financially, combined with good earned revenue results, enabled the Museum to conduct its fullest range of programs ever while maintaining an operating surplus.

Exhibits, education, collections management and preservation—each area will offer a rich program in both real- and cyberspace in the coming year. I hope you will participate with your enthusiasm, ideas, and support so that we can forge ahead and turn ambitious plans into reality.

Oliver Strimpel

**Oliver Strimpel**
Executive Director
strimpel@tcm.org



Photograph: David Thibideaux

## THE COMPUTER MUSEUM, INC. BALANCE SHEET / JUNE 30, 1995

| | Operating Fund | Capital Fund | Endowment Fund | Plant Fund | Total 1995 |
|---|---|---|---|---|---|
| **ASSETS** | | | | | |
| **Current Assets** | | | | | |
| Cash and cash equivalents | $271,682 | | | | $271,682 |
| Receivables and other assets | 171,532 | | | 18,000 | 189,532 |
| Store inventory | 50,191 | | | | 50,191 |
| Interfund receivable | | 305,390 | | | 305,390 |
| *Total Current Assets* | 493,405 | 305,390 | | 18,000 | 816,795 |
| **Other Assets** | | | | | |
| Restricted cash equivalents | | | 250,000 | | 250,000 |
| **Property and Equipment:** | | | | | |
| Equipment and furniture | | | | 358,271 | 358,271 |
| Capital improvements | | | | 964,245 | 964,245 |
| Land and building | | | | 1,603,221 | 1,603,221 |
| Exhibits | | 94,376 | | 5,780,794 | 5,875,170 |
| | | 94,376 | | 8,706,531 | 8,800,907 |
| Less - accumulated depreciation | | | | (4,592,239) | (4,592,239) |
| *Net Property and Equipment* | | 94,376 | | 4,114,292 | 4,208,668 |
| **TOTAL ASSETS** | **493,405** | **399,766** | **250,000** | **4,132,292** | **5,275,463** |
| **LIABILITIES AND FUND BALANCES** | | | | | |
| **Current Liabilities** | | | | | |
| Accounts payable and other current liabilities | 143,745 | 13,271 | | | 157,016 |
| Deferred revenue | 68,879 | 461,423 | | | 530,302 |
| Interfund payable | 305,390 | | | | 305,390 |
| *Total Current Liabilities* | 518,014 | 474,694 | | | 992,708 |
| **Bond Payable** | | | | 429,333 | 429,333 |
| **Fund Balances** | | | | | |
| Unrestricted | (24,609) | | | | (24,609) |
| Restricted | | (74,928) | 250,000 | | 175,072 |
| Net investment in plant and exhibits | | | | 3,702,959 | 3,702,959 |
| *Total Fund Balances* | (24,609) | (74,928) | 250,000 | 3,702,959 | 3,853,422 |
| **TOTAL LIABILITIES AND FUND BALANCES** | **$493,405** | **$399,766** | **$250,000** | **$4,132,292** | **$5,275,463** |

## STATEMENT OF ACTIVITY AND CHANGES IN FUND BALANCES FOR THE YEAR ENDED JUNE 30, 1995

| | Operating Fund | Capital Fund | Endowment Fund | Plant Fund | Total 1995 |
|---|---|---|---|---|---|
| **SUPPORT AND REVENUE** | | | | | |
| Unrestricted gifts | $869,698 | | | | $869,698 |
| Restricted gifts | 779,899 | 1,871,253 | | | 2,651,152 |
| Memberships | 204,390 | | | | 204,390 |
| Admissions | 556,802 | | | | 556,802 |
| Auxiliary activities | 494,842 | | | | 494,842 |
| Miscellaneous | 12,565 | | 10,106 | | 22,671 |
| **TOTAL** | 2,918,196 | 1,871,253 | 10,106 | | 4,799,555 |
| **EXPENSES** | | | | | |
| Exhibits and programs | 623,041 | 430,580 | | | 1,053,621 |
| Marketing and membership | 341,151 | | | | 341,151 |
| Depreciation | | | | 857,237 | 857,237 |
| Supporting services: | | | | | |
| Management and general | 365,688 | | | | 365,688 |
| Fundraising | 707,268 | 5,814 | | | 713,082 |
| Occupancy | 316,842 | 40,172 | | | 357,014 |
| Auxiliary activities | 531,553 | | | | 531,553 |
| **TOTAL** | 2,885,543 | 476,566 | | 857,237 | 4,219,346 |
| **EXCESS (DEFICIENCY) OF SUPPORT AND REVENUE OVER EXPENSES** | 32,653 | 1,394,687 | 10,106 | (857,237) | 580,209 |
| **FUND BALANCES, BEGINNING OF YEAR** | (49,724) | 312,425 | 250,000 | 2,760,512 | 3,273,213 |
| **ADD (DEDUCT) TRANSFERS** | | | | | |
| Exhibits placed in service and equipment purchases | (17,644) | (1,702,040) | | 1,719,684 | |
| Bond repayments | | (80,000) | | 80,000 | |
| Investment income | 10,106 | | (10,106) | | |
| **FUND BALANCES, END OF YEAR** | **$(24,609)** | **$(74,928)** | **$250,000** | **$3,702,959** | **$3,853,422** |


# On November 12, 1994

**— our tenth anniversary in downtown Boston — The Computer Museum opened *The Networked Planet*,™ a major 4000-square-foot exhibit on the applications, technology, history and impact of the growing computer network infrastructure that is increasingly becoming part of everyday life.**

The exhibit shows how computers, and the networks that connect them, are almost as essential as electricity. Using a variety of hands-on, interactive experiences, visitors learn about all kinds of computer networks, from the telephone system to financial networks to the largest network of all, the Internet.

To achieve this, the Museum turned to leaders in the field of networking, bringing together a veritable "United Nations" of computer and networking technology: a high-speed T1 connection to the Internet provided by Sprint, over 30 Mac AV computers provided by Apple Computer, Novell's Netware 4 networking software to connect all the computers together, a Chipcom hub, routers from both Wellfleet and Cisco, high-end graphic workstations from Sun Microsystems and Hewlett-Packard, and a fault-tolerant Internet server from Stratus. Most of this cutting-edge technology resides in the Network Control Center, where visitors can see how networking technology works in real time and is juxtaposed to an additional piece of hardware, no longer in operation: an original Interface Message Processor (IMP) that served to connect computers on ARPAnet, the precursor to the Internet.

The technology, of course, helped to put into action the many hours of planning, design and programming provided by staff and an army of dedicated volunteers. Our two advisory boards ensured that the content of the exhibit was correct and well-balanced. Experts from NYNEX, S.W.I.F.T. and the Harvard Community Health Plan helped collect and interpret the information that became part of the interactive exhibits.

The result is an exhibit with over 60 computers, high-speed access to the Internet, off-site representation in the form of a World Wide Web site, <http://www.tcm.org.>, and, based on summative evaluations, positive visitor response. Catching the wave of the public's fascination with the "Information Highway," *The Networked Planet* exhibit helped to break The Computer Museum's attendance record for FY '95.

## A Trip along the Information Highway

*The Networked Planet* exhibit is designed as a trip along an information highway, with areas dedicated to applications and the impact of computer networks. But with an exhibition space of just under 4,000 square feet, the exhibit staff and advisors had to make tough decisions about which stops to feature along the highway.

Examples were chosen to illustrate the use of live feeds of information, social and technical issues, the global character of the network, local applications, and subjects that would be of interest to family visitors. Major off-ramps take visitors to a telephone network, a financial network, airline and weather networks, telemedicine, and the Internet. Minor excursions via video kiosks look at other applications, such as retailing, transportation, telecommuting, employee monitoring, and computerized fingerprinting.

To provide perspective, an historical timeline lets visitors zoom from the era when the first telegraph message announced, "What has God wrought?" in 1844 to maps showing the evolution of the ARPAnet into the Internet in the 1980s.

## The Visit

After a brief introductory film, visitors are issued key cards, which they use to join the exhibit's local area network. Visitors log on with their name, sex, age, and zip code, and are asked to choose whether they want to keep their information private or public. If they select the "public" setting, the system allows for a "Who's out there?" option, by which they can "spy" — that is, see the location of everyone in the exhibit who is logged on. If they choose "private," no one has access to their information, but they also have no access to other visitors' information.

When visitors log on, they also get to pick one of four "Network Guides," electronic tour guides who provide commentary on the exhibit. The guides, chosen to represent diverse perspectives, tell stories that illuminate technical and social questions. Each gives clues to his or her unique perspective and background so that a visitor can make a choice of the approach of his guide, as well as the option to have subtitles in Spanish. A capsule view of each guide follows.

**ERICA, a wife and mother who runs her own business consulting firm from home:**

"Computer networks let me run my business from my house, which is great because I'm here when my kids come home from school. But it's not always easy keeping my family life and business separate."

**JESSIE, a teenager who by day is a computer programmer, by night a creator of computer games:**

"Come fly with me through the computer networks. You can't make reservations, you don't need a passport, and there are no boundaries."

**BEATRICE, a book editor in her fifties:**

"At the publishing house where I'm an editor, we use computer networks throughout the publishing process. Computer networks have changed the way we make books, but I can't say they've made the books themselves any better."

**MAX, a social worker working with the homeless:**

"A lot of people don't have access to technology. What I do is I use the technology — like computer networks — to help these people out, get them more connected."

## A Computer-Animated Ride Down a Phone Line

**Analog lines leave an out-going call.**

**Lines switch at a switching station.**

**Digital lines are used for the long haul.**

**Lines switch again.**

**Analog lines go to a final destination.**

Animations by Ed Hill

## The Telephone Network

From the time of the Carterfone decision in 1968, when the FCC said that digital bits could be sent over phone lines, telephone lines have been used for digital network connections. But most people have no idea what happens after the wire leaves the wall. The exhibit fills this gap of knowledge by providing a computer animation, created by animator Ed Hill, that slows down the action and illustrates the various transformations that occur in any phone call.

While the exhibit reveals the almost miraculous technology of a telephone network, the commentary of the guides brings out some of the social issues. Max, for example, queries the visitor: "What about people without phones? The homeless people I work with don't have a number where a social service agency, a potential employer, or landlord can reach them. In this society, if you can't be reached by phone, you are invisible."

## International Financing and Banks

The exhibit needed to show that while the old saying, "money makes the world go 'round," may be true, computer networks are what make money go around the world. No longer does someone need to be on the floor of the stock exchange to see the latest transaction. A variety of services brings these transactions right to the desktops of people around the world. Our live ILX feed, provided by Thomson Financial Services, allows visitors to view stock exchange transactions as they happen. Visitors can stand and watch as a stock symbol changes from green (while it is going up) to red on a down-turn, and they can also track the monthly progress of any stock they choose.

To enforce the extremely fast pace of making financial transactions, a simulated situation was created where each visitor gets a million "cyber-bucks" to invest in four constantly changing global markets, with visitors competing against each other to see who can make the most profitable investments. The closing times of foreign markets emphasize the global quality of the financial networks, as do other simulated purchasing opportunities, from African kenta cloth to New Zealand kiwi fruit.

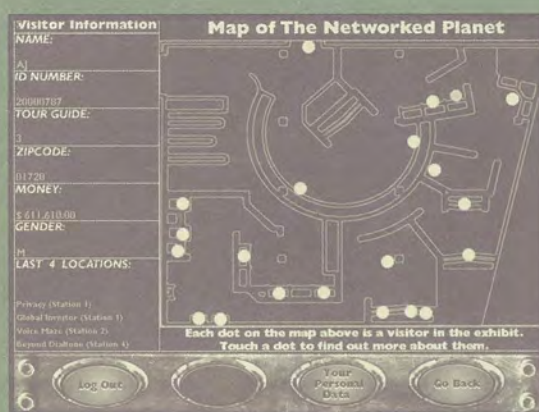
Since the 1970s when Marshall McLuhan said that "cash is a poor man's credit card," money has become an increasing abstraction. Network Guide Erica expresses a common kind of problem: "The other day when I was out shopping with my son, he asked me to buy him an overpriced stuffed animal. I told him it cost too much. He said, 'Momma, just get some money out of the machine.' He thinks cash machines give you money any time you want it. It's hard teaching my son about the value of money when he thinks you can get all the money you want, anytime you want, out of a machine."

## Probing the Privacy Issue

**When Congressman Ed Markey visited *The Networked Planet* and was faced with the choice of keeping his information private or public, he aptly noted that in the real world you have no choice about who has access to your information. The exhibit tries not merely to present the technology involved in global networks, but also to increase visitors' awareness about attendant social implications. Here, for example, two Network Guides discuss both sides of the privacy issue:**

### Jessie

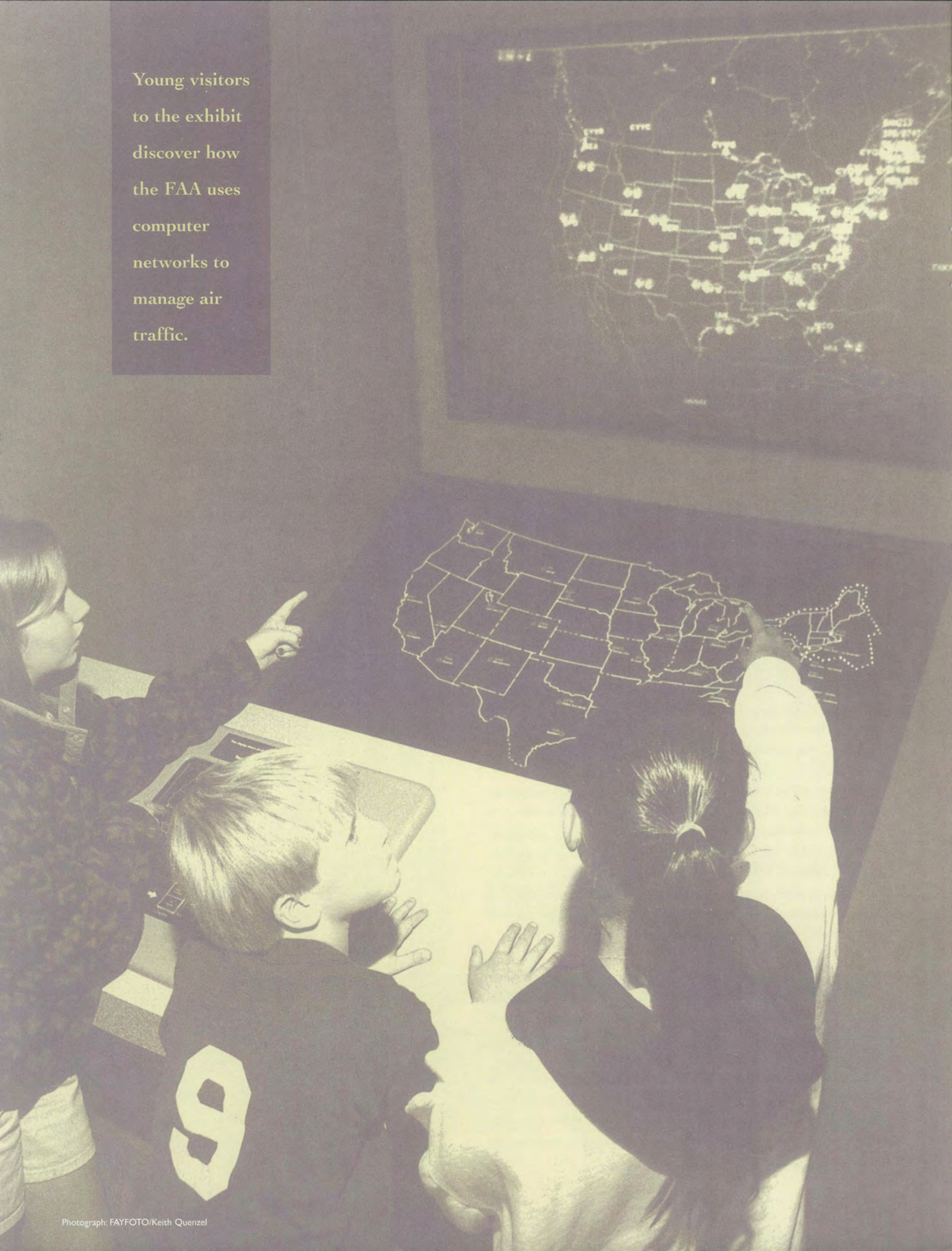
"On the networked planet there's a lot of information about you, spread out over many different networks. Where you shop, what you buy, your birth date, your shoe size, and even how many parking tickets you haven't paid. I never give anyone my social security number. There's a lot of information tied to that number — your driving record, school and medical records. People who get your social security number and understand networks can find out almost anything they want to know about you."




This screen image shows the location of the visitors logged on at various stations in *The Networked Planet* exhibit.

### Beatrice

"I know a lot of people think computer networks intrude on their privacy — that too many people know too much about them. But sometimes I want to share information about myself. When I applied for a mortgage to buy a house, it was approved partly because my credit rating is very good. The bank knew that I am a low risk. Now, I don't know those people at the bank, and they don't know me. Without a credit report how could they have known I'm someone they can safely lend money to?"



Young visitors to the exhibit discover how the FAA uses computer networks to manage air traffic.

Photograph: FAYFOTO/Keith Quenzel

## Air Traffic Control

A direct link to the Air Traffic Control program used by the FAA provides a highly dramatic view of all the commercial planes in the air in the United States at any given minute. The networks let the air traffic controllers see the big picture by collecting information from multiple locations and sending it to one central source.

The system was designed to allow regional air traffic control managers to monitor the flow of aircraft across the country. It helps them to anticipate potential delays before they happen and to orchestrate a more manageable traffic flow for air traffic controllers.

### Here's how it works:

❶ Flight location information is collected. Twenty air traffic control centers across the United States track air traffic in their area using radar. Every three minutes, each center sends its latest radar information by phone or satellite to the John A. Volpe Transportation Center in Cambridge, Mass.

❷ Flight location information is processed. Computers at the Volpe Center collect the air traffic control centers' radar information and organize it into a "big picture" of all the airplanes' locations.

❸ A "big picture" of airplanes' locations is sent to over 50 centers. The data of all the airplanes' locations is sent via a network to computers in over 50 FAA installations (and *The Networked Planet* exhibit). This includes the 20 air traffic control centers and major airports, where flight control managers use the information to manage air traffic controllers. Standing at the exhibit, a visitor can see the locations of all the planes in the air change every three minutes and can select any city and get a close-up of their incoming flights.

## The Internet Sampler


The idea of the Internet can be difficult to understand without experiencing it firsthand. For many visitors, the exhibit's Internet Samplers provide their first ride on this most publicly hyped segment of the "Information Highway." The Samplers offer an easy on-ramp to the Internet, either by using Gopher or via the World Wide Web. Visitors can choose Internet sites to visit from the "hot lists" compiled by Museum staff and arranged in subject categories, or enter their own favorite Uniform Resource Locator (URL), or search the Net for their own interests using search engines and Net indexes.

This highlight of *The Networked Planet* exhibit is enhanced by the incredibly fast T1 connection service provided by the exhibit's principal sponsor, Sprint. The T1 line allows visitors to view graphic images and download audio and video clips relatively quickly. Here visitors can see for themselves the global nature of the Internet as they "surf" Web sites that include an online art museum in France, Sarajevo Alive On Line, a listing of events for Jerusalem's 3000th anniversary, the Australian Triathlon page, and the site of the African National Congress.

The Sampler's Main Menu also offers information on how the Internet works, the history and culture of the Internet, and how to join the Internet.

Since July, visitors have learned more about the Internet from hands-on demonstrations that are included with the price of admission. These are the first of many programs planned for *The Networked Planet*, as the Museum continues to educate the community about the Internet and other cutting-edge applications of network technology. Future programs include more advanced fee-based Internet training classes designed for the general public, for businesses, and for educators, and a video-conferencing system that will send The Computer Museum to remote sites and bring remote programs to the Museum.

The most far-reaching network project is The Online Computer Museum, which will be launched in March 1996. More than just an online version of The Computer Museum, this Web site will offer a unique online destination with online exhibits, forums, and research opportunities. Visitors can preview our ideas for The Online Computer Museum and read learn about our existing exhibits and facilities at our Web site, located at: <http://www.tcm.org/>.

### EXHIBIT ADVISORS

**The following individuals from industry and academia offered their valuable insights throughout the planning and implementation of *The Networked Planet*:**

**National Endowment for the Humanities Advisory Committee**

Robert Baum
*University of Florida, Gainesville*
Paul Edwards
*Stanford University*
Diane Forsythe
*Stanford University*
Thomas Hughes
*University of Pennsylvania*
Robert Kling
*University of California, Irvine*
John Ladd
*Brown University*
Lee Sproull
*Boston University*

**The Computer Museum Board Advisory Committee**

Edward Belove
Gardner Hendrie
David Mahoney
James McKenney
David Nelson
Howard Salwen
Paul Severino

From April 1-May 29, The Computer Museum hosted the world premiere of AARON, an expert system with its own painting machine built by artist Harold Cohen. Each day, the computer-driven robot controlled by AARON created an original color painting. From its first creation — recorded live on *Today* March 31 — *AARON* captured the imagination of thousands of Museum visitors and media worldwide. (An earlier, simpler version of AARON, which made black and white line drawings, engaged Museum visitors from 1987-1994.)

What follows are highlights from a conversation between Cohen and photographer Becky Cohen in March. Both art and text are excerpted from the exhibition catalog that she created.

**"Nancy with potted plant," painting 60" x 84", oil on canvas, computer-generated drawing, 1991; collection Robert and Deborah Hendel.**

**BC: AARON has been making drawings autonomously for more than two decades, and now you are celebrating its new ability to color its drawings with dyes and special brushes. How did you get it to paint?**

HC: Putting dye on paper is easy: You just build a machine! This one consists of a small robot arm carried around over a large flat table on what we call an "xy device." The arm has a "hand" that's able to pick up the cups and brushes ... located at the edges of the table, it manipulates the taps on bottles of dyes, and so on.

Of course, I'm joking about it being easy to build a painting machine. The truth is that it was a relatively straightforward task compared with writing the code that would give AARON the ability to think about color. That has been my major pre-occupation the past two or three years, and there would have been no point in building a machine if I hadn't been able to do it.

**BC: What people see in the Museum is the machine painting. What they can't see is how AARON is thinking about color.... Why was color a difficult problem?**

HC: Human beings can see the results of putting two colors next to each other and can proceed on the basis of this feedback. The program is able to keep a ... complete record of what it's doing, but it can't see in the same sense that you or I can. I had to come up with rules about color juxtaposition that would serve in place of the visual feedback that humans use. As a painter, with a lifetime of experience of color, I must obviously have known what some of those rules were, yet I found it frustratingly difficult to say what they were.

**Drawing generated by AARON, 1994.**

**BC: Were you able to map the rules you had built for the screen-based coloring program onto the coloring program for the painting machine?**

HC: Well, actually not. I spent some time trying to translate the red-green-blue mixtures that AARON specified into combinations of the dyes I was using, but it never worked to my satisfaction.... Finally, I abandoned that approach and started to build up a new version based directly upon the dyes.... I'd have much preferred to use oil paint, which I've always found to be the most versatile and ... beautiful of media. It wouldn't have been at all practical for the painting machine, unfortunately. Oil paint is a more or less transparent material, and you have to control the thickness of the paint film rather precisely to get the most from it. My machine is much too crude a device to do that; in fact, I'm not sure that any current robot could exercise that level of control.

**BC: What kind of dyes have you chosen? And why dyes? Do they suffer from impermanence?**

HC: Oh no, not at all. That was true in the nineteenth century, with some of the earliest industrial dyes, but no longer. I have a shirt that's been in the California sun for almost two decades and in and out of the washing machine I don't know how many times; it still has most of its original color.

I've been using these Procion fabric dyes for several years for working on paper; they're very beautiful in color and they all rate six or seven on a permanence scale from one to seven....

**BC: What programming languages do you use?**

HC: AARON is written in LISP and runs on a Silicon Graphics computer, while the painting machine is controlled by a PC — a generic 486 — and the program is written in C++.

When AARON generates a painting, it stores it in a file as a set of instructions. Most of these instructions will control the movement of the brush on the paper, both in making the initial drawing and in filling in the color. Some of them specify the mixing of dyes for individual areas of the painting, and

"Clarissa," painting 42" x 54", oil on canvas, computer-generated drawing, 1992.

**BC: Yes, I could see the brush following the internal contours of shapes as it was coloring; but it seems that AARON must also have a sense of portraiture: that it has some idea of what sorts of color might be good for clothing, or plants.**

HC: AARON has a very clear idea of what it is doing.

**BC: How does AARON assign color?**

HC: In AARON's understanding of the drawings, different elements are characterised by their different attributes. It knows, for example, that a face has two eyes, and it will never draw a face with three. To the degree that color is also an attribute of a face, there are a limited number of colors it can use. It would never decide to paint a face green because it doesn't believe that faces can be green. However, there is no such limitation on the assignment of colors to things like sweaters or backgrounds. Color assignment here reflects the program's concern for the color "signature" of the whole painting. If AARON decides to do a red sweater, for example, it will probably not decide to do a red background....

When I started work on the painting version of AARON, I was struck by the fact that we have a very poor vocabulary for talking about color relationships, and that almost all of what's been written as color theory has been either theory about color perception or theory about color measurement. There is almost nothing about color use.... Whenever I find myself faced with a problem about how the program should proceed, I've asked myself how I would proceed. I was deeply frustrated to find that I couldn't describe what was happening in my own head when I was manipulating color as a painter.

**BC: Your pictures tend to be sort of two-and-a-half dimensional: not 2D, not 3D, but somewhere in between — sort of like Pompeiian frescoes.**

some of them specify the size of brush to be used. The file is read over a network connection by the 486, which then interprets those instructions and scales the dimensions of the Silicon Graphics screen to whatever size drawing is being made. It also scales the volume of the dye to be mixed for any color and the size of the brush, and then it generates the lowest-level commands that drive the painting machine.

To do everything it is supposed to do, the 486 program has to control the movement of the arm across the table, the horizontal rotation of the shoulder, the vertical rotation of the elbow, two rotations of the wrist, the opening and closing of the hand, and the reach — how far the hand can extend from the elbow. The program also has to know where the cups and brushes are kept, where the tap handles are and how much to move them up and down, and so on.

**BC: So, the order of events is: AARON first generates the drawing, then the coloring for the drawing, and finally sends orders to the 486. AARON never thinks about coloring before drawing, does it?**

HC: No, the drawing is done first, and then AARON decides about color. But the coloring part doesn't only involve the color choice. It must also map out the path the brush must take filling in the various shapes in the drawing.

HC: All representation is two-and-a-half dimensional, isn't it? The viewer is always confronted with a flat surface that evokes something in the physical — 3-dimensional — world.... It seems to me that the last 500 years of Western culture have been quite aberrant with respect to world history. At no other time in human history will you find our own characteristic obsession with appearances, nor its consequence, which led to the underlying technology both for photography and for computer graphics — the reflection of light off the surfaces of things in the world. That's a mystery to me. Do we really believe that we can find out the truth by the way things look?...

**BC: You seem to have created a sort of magical space where AARON's "organisms," figures, and plants have a special interrelationship with each other. Even in the room-like environments, it is as if the figures have a truly imaginative relationship with each other.**

HC: I ... hesitate on the word "imaginative" because that implies capabilities to the program that I know perfectly well [it] doesn't have. AARON's domain of expertise is the building of representations, not knowledge of the outside world. Hmm ... Well, it has some knowledge of the outside world.

**BC: Like what?**

HC: For example, it knows how people are put together. It knows how they are capable of moving. It knows how plants grow. It knows that rooms have walls at the back. It knows all of those things, though that isn't to say that it knows them in the same way that you or I know them. I suspect that whatever success the program has had has rested upon devising a representational mode perfectly fitted to the structure of its knowledge.

**Untitled, painting 54" x 42", oil on canvas, computer-generated drawing, 1991.**

**BC: It seems that you reinvented drawing as a means of reinventing color.**

HC: I was becoming increasingly disturbed and antipathetic towards the whole modernist movement in painting, in art. We had turned painting into a very specialized game that only a very few people could understand and respond to. I have always felt that the health of any art depends upon its relationship to the culture it serves, and I wasn't happy with where I stood.... I suppose that in turning away from color to spend several years investigating drawing, I was beginning to look for a way of getting back to a kind of imagery that would be available to more people.... Over time, I began to think that there was something slightly unsatisfactory about having AARON do all these drawings that I was then required to color.

**BC: From the beginning of your dialogue with your creation, you have always wanted its work to qualify according to your own high standards of interest, use, and beauty.**

HC: Of course, why would I demand less of it? One of the bargains I made with myself from the earliest days was that I would never accept the position of having to apologize because this was done by a computer. I have always insisted that the work the program did would have to stand on equal terms with art made by hand.

**BC: Still, you want what you've modeled in AARON and AARON's drawings to be truly within the domain of art. Presumably that is why you've spent so much time running the other way from so-called "computer art."**

HC: Yes. But ... my goals have changed subtly over the years. For a very long time, I thought AARON's work should be indistinguishable from the work made by human artists. That isn't quite the case any more. I want the work to look as if it has been made by an intelligence, but it doesn't have to be a human intelligence. I am much happier now when I see the program produce an image that looks as if it had been made by somebody who is seeing the world for the first time: seeing the world from a different point of view from someone who grew up human.

**BC: You give AARON a rather innocent quality, placing it just at the boundary of discovery all the time. I am wondering if you are ever surprised by any of the actions AARON takes....**

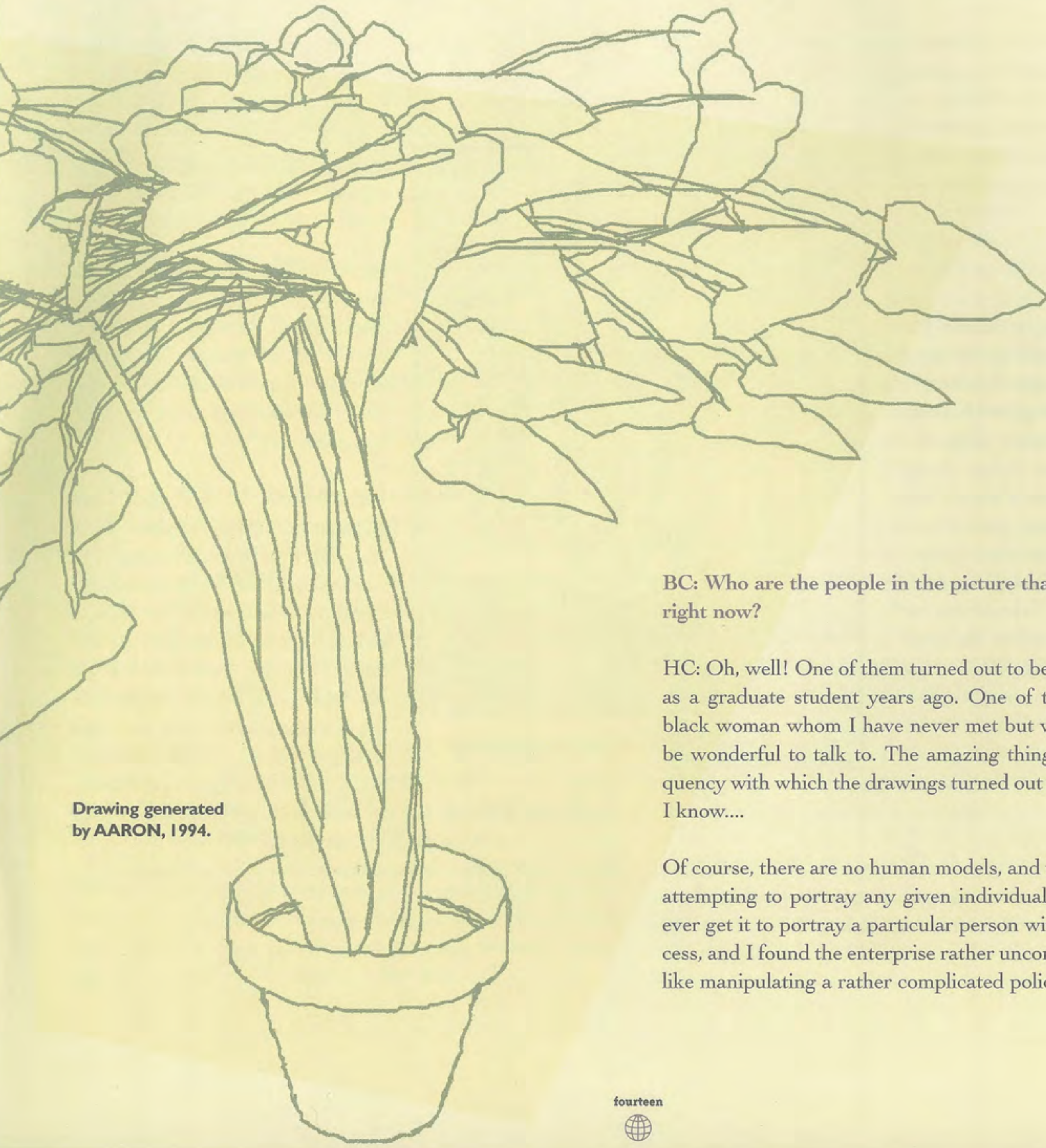
HC: I know exactly what AARON knows, but I can still be surprised. When you work on a program as I've worked on AARON, you make the program the heir to some subset of your own knowledge. When it plays that knowledge back to you, you can find yourself saying, "Hey, where did that come from? I didn't realize that that is what I believe." In that sense the whole endeavor is quite a shocking and remarkable experience....

**BC: Yet AARON has taught you something.**

HC: AARON is teaching me things all the way down the line. From the beginning, it has always been very much a two-way interaction. I have learned things about what I want from AARON that I could never have learned without AARON.

**BC: So, this decades-long conversation with AARON has enabled you to build on your own understanding of your own knowledge. AARON is probably the oldest, continuously-developed artificial intelligence program in computing history at this point. It has also allowed you to create a new medium for yourself as an artist, even to redefine what we mean by art.**

HC: Interestingly enough, I think the very age of the program contributes a great deal to the quality of what it does. Whatever else happens after 20 years of continuous development, AARON has a kind of complexity ... that you won't get when you sit down and knock off a program in three months or three years.

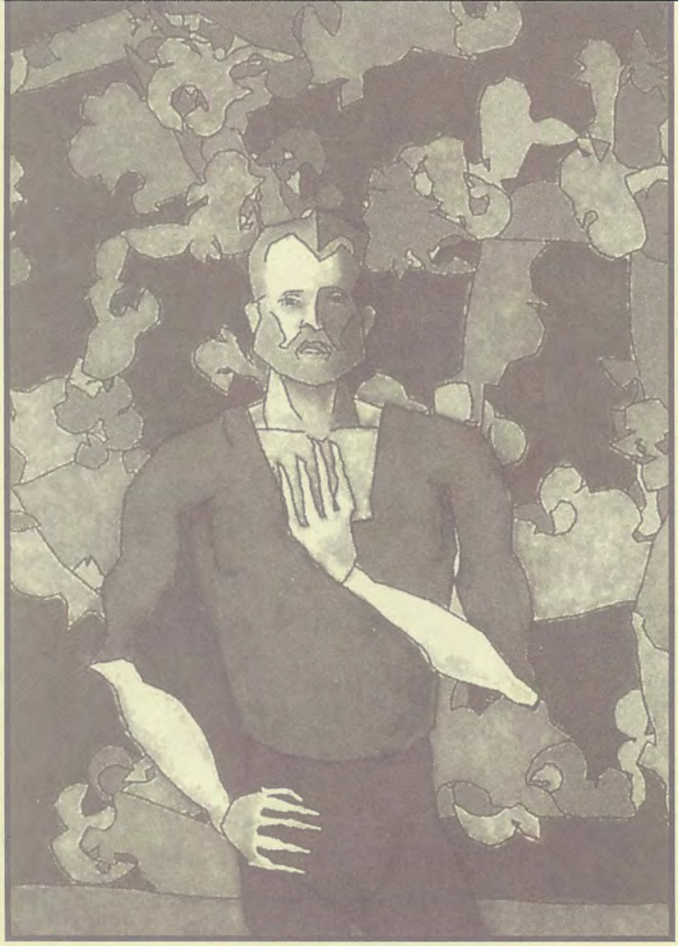


**Drawing generated by AARON, 1994.**

**BC: Who are the people in the picture that AARON draws right now?**

HC: Oh, well! One of them turned out to be someone I taught as a graduate student years ago. One of them is a graceful black woman whom I have never met but who I think would be wonderful to talk to. The amazing thing to me is the frequency with which the drawings turned out to look like people I know....

Of course, there are no human models, and the program is not attempting to portray any given individual. Only once did I ever get it to portray a particular person with reasonable success, and I found the enterprise rather uncomfortable ... It was like manipulating a rather complicated police identikit.



**"AARON with decorative panel," painting 72" x 54", oil on canvas, computer-generated drawing, 1992.**

BC: What artistic future are you indicating with your work?

HC: Public attitudes towards computers are by no means neutral. In a market-driven society, the manufacturer shoots for the biggest possible, not the most sophisticated, market.... The vast majority of users today identify the computer as a box on which to run ready-made packages.... There is no package for what I do, and there couldn't possibly be ... using one would be absolutely antithetical to the artist's position.... I am in the fortunate position of having been in this game from the time when there weren't any packages to be bought ... if you wanted a program, you wrote one.

EDITOR'S NOTE: To purchase the color catalog of AARON paintings, contact the Museum Store (617-426-2800 x 307). Harold Cohen or Becky Cohen can be reached through the information given below:

Harold Cohen
Center for Research in Computing and the Arts
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0037
(619) 534-4383/0188

Becky Cohen
Phone: (619) 942-7386
Fax: (619) 942-9602

BC: What traditional artistic goals have you been escaping for the last quarter century by casting your lot with artificial intelligence?

HC: I am not sure I am escaping any goals, or even trying to. Oh, of course it isn't exactly traditional to have a machine generate one's artworks. But—in the twentieth century, certainly—art-making is a highly self-reflective activity, and what is central is the degree to which the making of art contributes to an ongoing dialogue about the nature of art. In that sense I think my work is absolutely orthodox.

I have never subscribed to what I once called the telecommunication model of art: the artist has something in mind which is encoded in a message and sent across the art medium, or the Internet, or whatever, and is then received and decoded, with the result that the audience understands just what the artist had in mind....The artist is concerned with the design of meaning generators, not meaning communicators. The power of the program still is that it is capable of generating some personality on a piece of paper; it will initiate some response on the part of the viewer in terms of what the viewer knows about human personality and human experience.

**"Meryl," painting 24" x 34", oil on canvas, computer-generated drawing, 1993; collection Robert and Deborah Hendel.**

## COMPUTERS

**ACT (Computers) Ltd.**
**Apricot computer, 1984**
*Donated by Janet Baker. X1212.95*

**AT&T EO 440**
**portable computer, 1993**

**AT&T EO 880**
**portable computer, 1993**
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**Compaq Inc., portable**
**IBM PC-compatible, 1983**
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**Epson HX-20**
**laptop computer, 1984**
*Donated by Roger J. Hennessey. X1213.95*

**German National Research Center for Computer Science Reduction Machine, 1990**

"The inception of this machine goes back to the early seventies. At this time, the idea of 'Higher-Level Language Architectures' was investigated by many researchers. The GMD Reduction Machine was, however, strictly based on the lambda calculus and the principle of reduction or meaning preserving transformation and not on a particular programming language. Its architecture is based on a multi-stack automaton set up to traverse tree structures and is very different from a conventional von Neumann architecture.

"By 1975, Mr. Hommes had the machine completely simulated. Great care was deployed to implement the lambda calculus completely and correctly. All the problems with naming were overcome by using 'protectors,' which protect variable occurrences from wrong bindings. Later they turned out to be a special version of deBruijn indices.

"Measurements showed potential of providing reasonably fast symbol-processing power of the machine, which could be used to emulate Backus' FP system, list-processing, recursive functions, and much of conventional programming language constructs without compiling. Backus' idea of program transformations towards more efficient, but equivalent, forms could be demonstrated. In 1976 Dr. Kluge, now Professor in Kiel, Germany, joined the GMD and got interested in the machine. Our combined efforts and support by the management finally made it possible to design and construct an actual hardware model in TTL technology. It became operational early in 1978. Factorial 500 takes about 10 seconds and fills the screen with digits. This was impressive at that time. Although the machine raised some interest worldwide, the enormous progress in making faster and faster von Neumann processors turned the focus of development towards software solutions. The machine should still be operational." Klaus Berkling

*Donated by the German National Research Center for Computer Science. X1193.95*

**Microdata Computer Corporation, Inc.**
**32/s computer, 1976**

The 32/S was microprogrammed, in firmware, on the 3200 processor. Designed in conjunction with the PL/I-based Microdata Programming Language (MPL), the 32/S system enabled all programming to be done in a high-level language.

*Donated as part of the University of Southeastern Louisiana microprogramming collection. X1220.95*

**Tandy Radio Shack**
**TRS-100, 1980**
*Anonymous. X1210.95*

**VTC, Inc.,**
**Laser Apple II clone, 1987**
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**Zenith Data Systems**
**Model 171 prototype**
**laptop computer, 1983**
*Donated by Rich Carl. X1211.95*

## SUB-ASSEMBLIES AND COMPONENTS

**ETA Systems, Inc.**
**ETA10 printed circuit board and CMOS chip, CMOS chip interconnection layer mask; CMOS chip wafer**
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**Remington Rand**
**Univac File II Buffer**
**Processor II, 1962**
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**Telefunken TR-4**
**computer microprogram unit**
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**University of Illinois**
**CSX-1 logic module, 1962**
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**Zuse Computer Company**
**Zuse Z22 plug in module, 1956**
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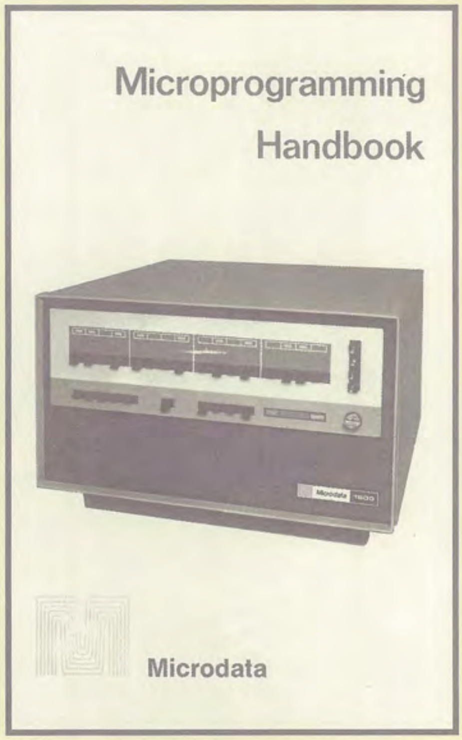
## MEMORIES

**Harvard University Computation Laboratory, Harvard Mark IV memory drum read/write head chassis, 1952**
*Donated by Walt Williams. X1217.95*

**International Business Machines, System/360 Capacitor Read-Only Store, 1965; System/360 Transformer Read-Only Store, 1965**

Capacitor Read-Only Store (CROS) — one of three control store microcode systems developed at IBM in the early 1960s — and dedicated software allowed IBM to efficiently make System/360 machines function like older products such as the 7070, the 1401 and 1410, easing customer acceptance of the new products and giving rise to the now-common term *emulation*. Donated as part of the University of Southeastern Louisiana microprogramming collection.

*Donated by the University of Southeastern Louisiana. X1218.95-X1219.95*




**The *Microprogramming Handbook* came with the 1976 Microdata Computer Corporation 32/s computer, donated as part of the University of Southeastern Louisiana microprogramming collection.**

**Remington Rand**
**Univac File II drum storage, 1958; drum controller, 1958; core storage, 1959**
*Donated by Jim Payne. X1199.95-X1201.95*

**Sanders Associates core**
**memory subsystem, c. 1968**
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### TRANSDUCERS

**Atari, Inc.,
Pong face plate, 1975**

*Donated by Russell Nelson. X1214.95*

**Hayes Micro Coupler modem, 1979**

The modem Steve Wozniak used with his Apple II, this 1200-baud modem was one of several Hayes products that dominated the burgeoning personal computer market in the early 1980s.

*Donated by Steve Wozniak. X1194.95*

**IXO Inc.
Telecomputing system, 1982**

Back to the future: In a 1982 *Byte Magazine*, Chris Morgan, then editor-in-chief, waxed enthusiastic about the IXO Telecomputer: "Imagine a terminal that costs $500 and can: access the Source, CompuServe, Dow Jones, or other remote database or computer services; automatically handle the protocols to access these services; have a full ASCII character set; have a built-in modem with autodialer; emulate other terminals; fit in your pocket; and operate from a battery." Bob and Holly Doyle, the original, Cambridge, Mass.-based IXO developers, donated a complete set of hardware, peripherals, software, documentation, and dealer materials to the Museum.

*Donated by Bob and Holly Doyle. X1209.95*

**SynOptics Communications collection, 1981-95**

*Donated by SynOptics Communications. X1173.95-X1190.95*

**Stratus Computer "phone home" remote service board, 1984**

*Donated by Stratus Computer. X1191.95*

**Tektronix, Inc., oscilloscope camera C-27**

*Donated by Ed Hill. X1208.95*

### SOFTWARE

**NSnipes,
first networked computer game, 1982**

*Donated by Drew Major and Novell/SuperSet Software, Inc. X1195.95*

**MIT Whirlwind computer program library, 1948-63**

The original Whirlwind program library, donated with the assistance of William Wolf, consists of thousands of paper and magnetic tapes with quick hacks, subroutines, I/O and other protocols, scientific, military, and academic applications, and other program elements. This donation also includes a number of Whirlwind components such as logic and memory modules, magnetic tape drives, and AC/DC converters.

*Donated by Susan Cooper. X1196.95*

### ELECTRONIC ARCHIVES

**Electronic Mail re E-mail, 1978-1986**

This archive of electronic mail on the subject of e-mail is from the MsgGroup, one of the first ARPAnet mailing lists to be established and then automated. It was administered and moderated by Einar Stefferud, with funding support from Steve Walker of ARPA IPTO, from May 10, 1978, to June 11, 1986. MsgGroup addressed "virtually every relevant issue related to e-mail use or system design," said Stefferud, founder of First Virtual Holdings Inc. "You will find much of the history of Internet e-mail there, including the first really huge flamefest, and the underpinnings of the current e-mail architectural model." The archive, which is 5389 kilobytes in length, includes more than 2600 messages from 100-200 individuals.

Stefferud collected and preserved the archive on ECL.USC.EDU at Network Management Associates, Inc.'s expense. Frank Wancho at White Sands Proving Ground copied and preserved it on SIMTEL-20, and Edward Vielmetti obtained a copy in 1990 to make it available through MSEN to the Internet community.

When Stefferud was president of Network Managment Associates, Inc., he decided to donate the archive to The Computer Museum for preservation and for the Museum to make it available to the Internet community. He explained, "The MsgGroup archives really belong collectively to all the contributors, and not to anyone in particular. I determined that The Computer Museum is the proper holder and preserver of the archives, in the interests of the MsgGroup contributors." Using software donated from First Virtual, the Museum plans to make the archive available for a nominal fee.

*Donated by Einar Stefferud, as president of Network Managment Associates, Inc., representing the MsgGroup contributors. E1.95*

### CARD PUNCH EQUIPMENT

**Remington Rand Univac Model 3 card punch, 1955; card verifier (British version), c. 1948**

*Donated by Jim Payne. X1203.95 - X1204.95*

### CALCULATORS

**National Semiconductor NS 900 calculator, 1983**

*Donated by Sam Christy. X1207.95*

### MICROPROGRAMMING COLLECTION

Bruce Shriver assembled the microprogramming collection at the University of Southwestern Louisiana. A large number of people contributed to this collection from around the world. The list of original contributors is kept with the document component of the collection. Every item that is part of the original collection is identified as such in the catalog. The Museum continues to add items and identifies other components appropriate to this collection. The artifacts from the collection are included in the list above.

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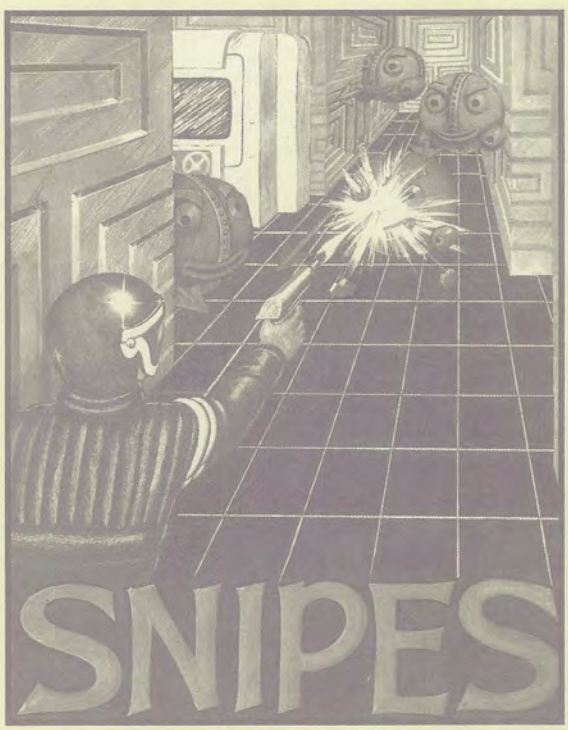


**This manual accompanied the floppy diskette for the original *Snipes* game.**

# THE 1995 COMPUTER BOWL

A one-of-a-kind fundraising event to benefit the Museum's educational programs, The Computer Bowl® plays out the legendary East/West Coast high-tech rivalry in a contest of computer knowledge. Played for the first time in cyberspace, the 1995 Bowl was conducted simultaneously and interactively on both coasts using state-of-the-art satellite technology. The score was the West 230 to 190 for the East.

Since 1988, the Bowl has raised more than $2 million in donations and in-kind support. It attracts the support of hundreds of sponsors and enthusiastic volunteers, as well as media coverage from around the world. The Seventh Computer Bowl would not have been possible without the support of those listed below.

Photograph: Chris Johnson

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**Scott Ford of Novell, Inc., explains how *The Networked Planet*'s own network enables the Network Guides to track visitors.**

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**From the left: Computer Museum Director Oliver Strimpel, *Robotic Artist* exhibit sponsors Gwen and Gordon Bell, and artist Harold Cohen watch AARON put the finishing touches on a painting.**

Photograph: Roger Farrington

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***Networked Planet* advisor and sponsor Paul Severino of Bay Networks (center) discusses the Internet Sampler with Vinton Cerf (right) and Simon Rakov (far left).**

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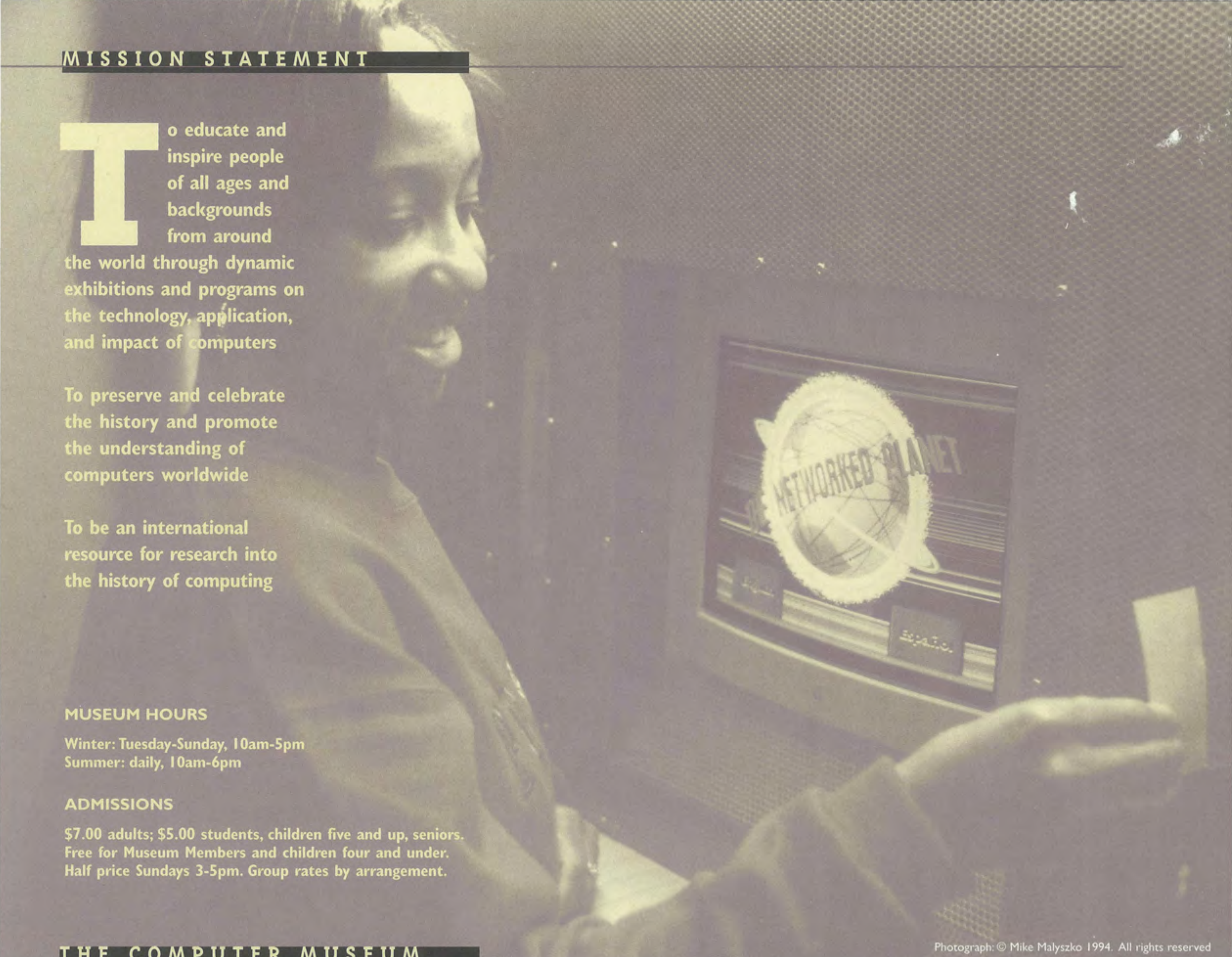


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