# PRESERVING ETHER: THE BIRTHPLACE OF THE INTERNET AND THE INTERPRETATION OF INFORMATION AGE TECHNOLOGY

by

MELISSA LEIGH IVEY

(Under the Direction of Mark E. Reinberger)

ABSTRACT

There are few technological innovations that have impacted the daily lives of Americans as profoundly as the Internet. The origins of the Internet lay in the ARPANET, an experimental computer network developed in the late 1960s by Bolt, Beranek and Newman, a company headquartered in Cambridge, Massachusetts. This thesis explores the issues surrounding the preservation and interpretation of Information Age sites and resources in general, and offers specific recommendations for the Bolt, Beranek and Newman site. The author argues that due to the ethereal nature of information technologies, methods commonly used to preserve and interpret technological history sites and resources will require modification to be successfully applied to those of the Information Age. Recommendations are based on the analysis of existing technological history sites, unique characteristics of Information Age sites and resources, and interpretive principles and programs.

INDEX WORDS: Historic Preservation; Interpretation; Exhibits; Information Age; Technological History; Internet; ARPANET; Bolt, Beranek and Newman; Cambridge, Massachusetts.

# PRESERVING ETHER: THE BIRTHPLACE OF THE INTERNET AND THE INTERPRETATION OF INFORMATION AGE TECHNOLOGY

by


MELISSA LEIGH IVEY

B.A., Vanderbilt University, 1996


A Thesis Submitted to the Graduate Faculty of the University of Georgia in Partial

Fulfillment of the Requirements for the Degree

MASTER OF HISTORIC PRESERVATION

ATHENS, GEORGIA

2003

PRESERVING ETHER: THE BIRTHPLACE OF THE INTERNET AND THE INTERPRETATION OF INFORMATION AGE TECHNOLOGY

by

MELISSA LEIGH IVEY

| | |
|---|---|
| Major Professor: | Mark E. Reinberger |
| Committee: | Wayde Brown<br>Judith Wasserman<br>Michael Callinen |

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
May 2003

# DEDICATION

In memory of my father, Curtis L. Ivey, Jr.

# ACKNOWLEDGEMENTS

My sincerest thanks to Mark Reinberger for his long-distance assistance and patience with this project. I would also like to thank all of those who took time out of their busy schedules to provide interviews and share their resources with me, including Ed Rodley at the Museum of Science, Sally Zimmerman at the Cambridge Historical Commission, Sally Hild at the Cambridge Historical Society, and Joyce Kuzmin and Ray Tomlinson at BBN Technologies. Special thanks to Bob Krim at the Boston History Collaborative for inspiring me to pursue this topic and for providing me with an extraordinarily flexible work schedule while I completed it.

Lastly, my eternal gratitude to Peter Wiley for his unconditional support, words of encouragement, patience, humor and strength. I could not have done this without him.

# TABLE OF CONTENTS

# LIST OF FIGURES

Page

# INTRODUCTION

Few technological innovations have impacted the daily lives of individuals as significantly as the Internet. As of April 2002, approximately 166 million (60%) of all American households had Internet access[1], and for many of those who are "online", the Internet has revolutionized the way in which they communicate, access information, do business, and spend their leisure time. The birthplace of this technological wonder is located in Cambridge, Massachusetts at the office complex of technology firm, Bolt, Beranek, and Newman (BBN).

Virtually unknown to everyone with the exception of the occasional computer or technology enthusiast who has sought it out, the site is of great historical significance on the local, national and international levels as it is where the ARPANET, the conceptual and technological forerunner of the Internet, was built. As of today no action has been taken to have the site recognized as historically significant or to develop any type of interpretive programming either at the site or elsewhere.

Given the relatively young age of sites associated with Information Age technological innovations, there is little precedent for undertaking the preservation or interpretation of a site such as this. (For clarification, interpretation, as used in this context, may be described as "an educational activity that aims to reveal meanings about

---

[1] Nua.com, "How Many Online?" (Ireland: Computer Scope, Ltd, 2003).

our cultural resources".)[2] There are many potential challenges to the processes, particularly the ethereal nature of Information Age technology and the often nondescript nature of associated physical resources. Traditional approaches to preservation and interpretation must be adapted to suit the characteristics of this new type of site and history. This thesis makes recommendations for preservation and interpretation options that may be undertaken for the BBN site, including historic designation, on-site interpretative programs, and the development of a Cambridge area "technology trail".

The undertaking of this study at this point in time is significant. The preservation of many historic resources is not considered until the site or resource is threatened. Due to time pressures, this often results in a reactionary plan that is aimed at saving the resource from imminent destruction, but lacks coherent and logical consideration for the importance and relevance of the resource. Present consideration of the historic value of the BBN site will allow for greater amounts of research and planning, avoiding last minute and hasty decisions that could be detrimental to the resources involved.

The first chapter provides a brief overview of the history of the ARPANET, the firm of Bolt, Beranek and Newman and the ARPANET's connection to the Internet. The political, social, and technological climates are discussed to provide context for the innovation.

In the second chapter, the preservation and interpretation of existing Information Age technological history sites and resources are examined. Sites that have received historic status are discussed, as are current technology and Information Age technology

---

[2]Larry Beck and Ted Cable, Interpretation for the 21st Century (Illinois: Sagamore Publishing, 1998) xi.

interpretive exhibits. These exhibits are evaluated in regard to commonly accepted principles of successful interpretation.

The case for historic significance of the BBN site is made in chapter three. Using the criteria set forth by the National Register of Historic Places, this statement of significance provides the foundation on which further preservation and interpretive action may be taken.

The last chapter outlines recommendations for the preservation of the BBN site. Included are suggestions for seeking local historic recognition and increasing the awareness and visibility of the site. Suggestions for various types of interpretive programming, both on-site and off-site, are also provided.

# CHAPTER 1

# EARLY HISTORY OF THE INTERNET

There is no “father” of the Internet. The revolutionary technology that enables computers across the country and around the world to communicate with one another did not spring from one engineer's drawing board. Rather, the conception and successful engineering of the Internet can be attributed to a multitude of people who poured their brilliant ideas, perseverance, technical expertise, and sense of adventure into a project called the ARPANET. The forerunner of the today's Internet, the ARPANET was a Department of Defense project commissioned in the early 1960s that was undertaken by the engineers of Bolt, Beranek and Newman, a small technology firm in Cambridge, Massachusetts. (Our condolences to Al Gore.)

## The ARPANET

The origin of the ARPANET concept lies within the Department of Defense, at the time of the Soviet Union’s successful launch of the Sputnik satellite in October of 1957. The event sent shockwaves through the United States as it bore witness not only to the fact that the Soviets now had a lead in the US/Soviet space race, but more disturbingly, that the they possessed the technological capacity to launch rockets into orbit. President Eisenhower responded immediately by assembling a meeting of his Presidential Science Advisory Committee to address the situation. He decreed that the

United States would "never again be taken by surprise on the technological frontier".[3] To this end he created a new agency within the Department of Defense to centralize defense research and eliminate much of the bureaucracy that is often accused of hindering research and technical innovation. The Washington, D.C.-based agency was named the Advanced Research Projects Agency (ARPA) and brought together some of the most brilliant and talented engineers and scientists in the country to research and develop experimental and cutting-edge technology.[4] (The agency still exists today as DARPA-Defense Advanced Research Projects Agency.)

At its inception, ARPA was extraordinarily well funded with an appropriation of $520 million and a budget plan of $2 billion.[5] This did not last long however; in 1958 a separate agency was spun off of ARPA to handle space and missile research. This agency, the National Aeronautics and Space Administration (NASA), relieved ARPA of its responsibilities in the area of space research, in addition to about 75% of its budget. ARPA was forced to redefine its mission just to stay in existence and proposed to re-focus on computer science, information processing, high technology, and other radical endeavors. This new mission was well received by Washington, particularly within the new Kennedy administration, which astutely believed that "science was the new frontier", and that being on the cutting edge of technology was imperative to the United States' goal to maintain world supremacy.[6]

In the early 1960s, the "new" ARPA projects were directly defense-related for the most part, including research in ballistic missile defense and nuclear test detection. In

---

[3] Hafner, Katie and Matthew Lyon, Where Wizards Stay up Late (New York: Touchstone, 1996) 14.
[4] Ibid., 18-20.
[5] Ibid., 20.
[6] Ibid., 23.

1962, ARPA acquired a supercomputer, the Q-32, from the Air Force (which could no longer afford it due to budget cutbacks), and ARPA's focus on computer science became stronger[7]. A new division was established within ARPA, The Information Processing Techniques Office (IPTO), which was given the task of conceiving of, and developing uses for computers beyond using them as advanced calculators.

Computers had been used by the military and a few industries for many years at this point, but solely for the purpose of performing mathematical and scientific calculations very rapidly. These early computers were called "supercomputers" due to their enormous size and were very few in number. Among the first supercomputers were: the ENIAC, at the University of Pennsylvania, used by the Army; Whirlwind, at Massachusetts Institute of Technology (MIT), supported by the Navy and the Air Force; and the Mark I, also supported by the Navy (see figure 1.1).

The first director of IPTO was J.C.R. Licklider, a brilliant thinker who in the early 1960s coined the term, "intergalactic computer network",[8] an aptly-named concept of connecting computers in remote locations deemed fantastical and impossible at the time. Within a few years, however, his ideas would prove to be right on target. A fellow ARPA employee, Larry Roberts, described Licklider's foresight and influence:

> [Licklider] had this concept of the intergalactic network… everybody could use computers anywhere and get at data anywhere in the world. He didn't envision the number of computers we have today by any means, but he had the same concept… The vision was really Lick's originally. None of us can really claim to have seen that before him…[he] saw this vision in the early sixties. He didn't have a clue as how to build it…But he knew it was important, so he sat down with me and …convinced me to move into making it happen.[9]

---

[7] Ibid., 24.
[8] Segaller, Stephen, <u>Nerds: A Brief History of the Internet</u> (New York: TV Books, 1999) 39.
[9] Ibid., 40.

Licklider's ideas of advancing computers beyond their use as mere calculating machines, to tools that could actually serve as partners to man in decision-making processes, influenced and inspired those around him, particularly Bob Taylor, who in 1966 became director of IPTO. While in this position, Taylor approached the director of ARPA with a proposal to fund an experiment he and Licklider had discussed many times, but never acted on. The proposed experiment was to create a small computer network.

Taylor explained to the director that the large supercomputers at the research universities (which were IPTO contractors) should be connected to avoid duplication of work being done at each of the institutions, and to limit the other myriad inefficiencies in the current system. His pitch was this: "By building a system of electronic links between machines, researchers doing similar work in different parts of the country could share resources and results more easily."[10] Taylor requested funding to build a small test network, to begin with four nodes, or host sites, and to work up to about twelve. The funding was granted. Taylor chose Larry Roberts to manage the project, and in late 1966, Roberts arrived at ARPA with a loose sketch of how the network would look, already in hand (see figure 1.2). Roberts knew however, that accomplishing this was not going to be an easy task, and that any chance of success was going to require the help of most of the experts in the computer field.[11]

The sketch of the network was a result of collaboration and debate among Roberts, his colleagues, and other experts in the field. The basic structure of the network

---

[10] Hafner 42.
[11] Segaller 47.

would require the construction of "interface message processors", or IMPs, which would serve as intermediate computers to be connected to one another in a sub-network. One IMP would be located at each of the four host site (University of California at Los Angeles, Stanford Research Institute, University of Utah, and the University of California at Santa Barbara) and would transmit information to one another using "packet-switching" technology--the cutting-edge technology that made this type of network possible. Simply stated, packet-switching technology breaks down data into small “packets” of information which are then sent through the network individually and reassembled at their destination.[12] The host sites would then connect their own host computer to the IMP to serve as the interface to the network.

The four initial host sites were chosen based upon their status as the leading computer centers in the country and for having the resources and engineers necessary to function as a node on the ARPANET. These sites, in addition to subsequent host sites, had been under contract with the Department of Defense for research in the computer science field since the early 1960s. Licklider instigated these contracts during his time at ARPA.[13]

---

[12] Ibid., 397.
[13] Hafner 38.

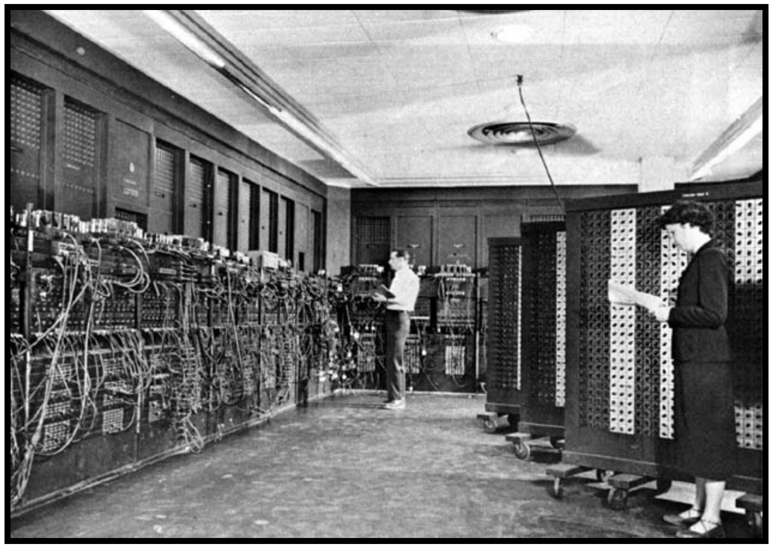

Figure 1.1. The ENIAC computer at the University of Pennsylvania's Moore School of Electrical Engineering, 1946

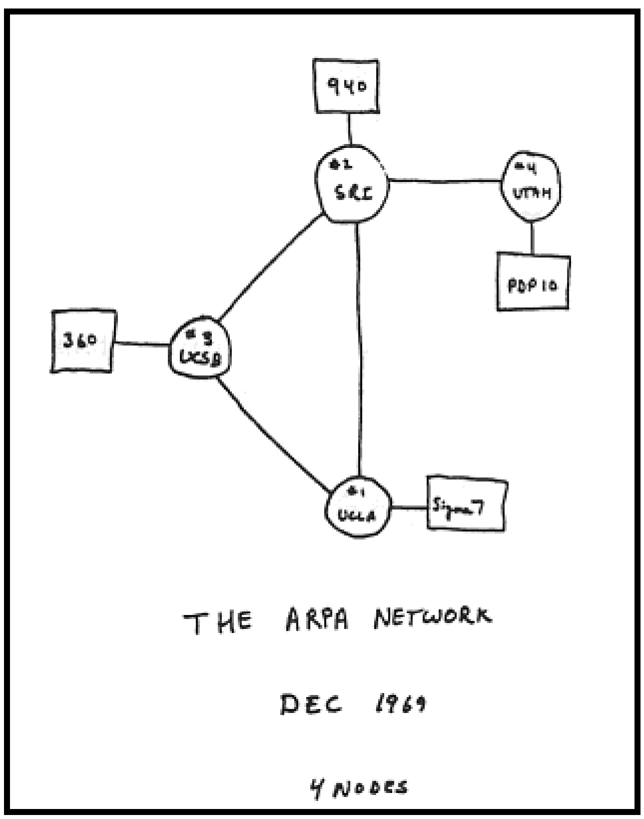


Figure 1.2. Early sketch of the ARPANET network. (Image courtesy of Computer History Museum)

With the basic specifications for the network established in July of 1968, ARPA sent a “Request for Quotation” (RFQ) out to 140 companies, including IBM, Digital, Computer Corporation of America, Raytheon and Bunker-Ramo.[14] The RFQ was a solicitation for competitive bids for the job of building what was now being referred to as the "ARPANET". The document outlined the exact characteristics of the four IMPs, and how the network should function, but what it did not include was how they should be *built*. The task at hand, as described in the RFQ, was to invent "the first-ever digital processor network, with packet-switching technology, a half-second response time, sophisticated measurement capability, and continuous operation, with no downtime for servicing."[15] Many companies, including industry giants such as AT&T and IBM thought that building this network was not possible, while others simply did not know where to begin. Only twelve proposals were submitted. Raytheon, already a defense contractor, submitted an excellent proposal, and ARPA began financial negotiations for the project with them. At the last moment, however, the job was given to a small firm called Bolt, Beranek and Newman[16].

**Bolt, Beranek and Newman**

Bolt, Beranek and Newman had it beginnings in 1948 as a small architectural acoustics consulting firm. They received great notoriety within a very short period of time for a company of their size and won high profile contracts for acoustical design of buildings such as the United Nation's General Assembly Hall. Over time, they had

---

[14] Ibid., 80-81.
[15] Segaller 70.
[16] Hafner 81.

garnered an impressive list of achievements, including being chosen by the United States government to analyze the Kennedy assassination and Kent State audio tapes.[17] BBN did not focus on computer research until J.C.R. Licklider, a new employee in the late 1950s (before he went to ARPA), suggested to Leo Beranek that they purchase a computer (not a common, practical or inexpensive purchase at the time).[18] Fortunately, Beranek agreed and the firm has been on the cutting edge of computer science and networking ever since.

When BBN received the request to build the ARPANET, they had only thirty days to figure out how they would build the IMPs and give them the ability to communicate with one another, in addition to assembling their proposal. Fortunately, BBN had been consulted early in the conceptual stages of the project and had already thought quite a bit about how to make this project a reality. Frank Heart, a veteran MIT computer systems engineer, who had a reputation for being able to build just about anything, assembled and led the team that produced the proposal and ultimately built the network. The other members of the team included: Bob Kahn, an electrical engineering professor on leave from MIT and "consummate theoretician who understood error-control and the problems associated with sending data over telephone lines;" Dave Walden, a young programmer and an expert in real-time systems; Bernie Cosell, the expert de-bugger who specialized in rescuing projects that were in trouble; Severo Ornstein, the hardware expert; and Will Crowther, an extraordinary programmer who specialized in writing very tight, complex pieces of code, or software (see figure 1.3).[19]

[17] BBN Technologies, BBN Technologies: Where the Possible Becomes Real (Cambridge: BBN Technologies, 2002) 37-42.
[18] Hafner 84.
[19] Ibid., 161.

They worked around the clock for four weeks straight, tackling questions such as which commercial computers to use as the foundation for the IMPs (they chose a Honeywell), how to make the sub-network of IMPs transparent to the user (this would require the network to be very fast and reliable), and whether or not they would be able to write the complex code that would be necessary to make this whole thing work (they were). One month later, the completed proposal was two hundred pages in length and cost more than $100,000 to produce.[20] Although in their proposal BBN wrote, "we take the position that it will be difficult to make the system work,"[21] ARPA believed that BBN had offered the best solution to the problem. Another advantage BBN had was their relatively small size and a lack of a bureaucratic hierarchy, which Roberts felt would make communication between ARPA and the team easier, the research quicker, and the whole project both more stable and more agile. BBN received word that their proposal had been chosen in December of 1968. Massachusetts Senator Edward Kennedy, upon hearing the news that this small Cambridge firm had just received a million dollar ARPA contract, sent a telegram to BBN congratulating them on their contract to build the "Inter*faith* Message Processor."[22]

Frank Heart expressed his surprise at receiving the contract:

> It was a very exciting time, because we certainly didn't know we were going to win…We vacillated between thinking we had written the best proposal since we knew the most, to thinking it was impossible for the government to give the job to a small company when there were other large organizations bidding. So it was certainly a very pleasant surprise to have won.[23]

---

[20] Ibid., 97-100.
[21] Segaller 77.
[22] Hafner 102.
[23] Segaller 79.

They did not have much time to think about it, however, because they had only nine months from the date they were given the contract to deliver on the first IMP that was to go to UCLA, and work got underway at a furious pace. Over the next nine months they would figure out how to make packet-switching technology work, rework a Honeywell "minicomputer" so that it could function as an IMP, write software for the IMPs, and get the packet-switching technology-wary telephone companies to lease and install 50-kilobit telephone lines to connect the hosts.[24] AT&T, the long-distance monopoly at the time, actively tried to discredit the concept of "packet switching" by claiming that it was not possible and could cause problems with telephone service which used the "circuit switching" technology. The BBN team faced a multitude of challenges during those nine months. They had to wrangle with Honeywell to take delivery of a computer that was built to their specifications. “Bugs" that caused the IMP to crash at random intervals had to be worked out of the system. And there were a bevy of potential technological roadblocks along the way, not surprising considering this was completely uncharted territory.

There were many vital contributions to the ARPANET project from outside of BBN. BBN's main task at hand was to deliver IMPs that would be capable of moving packets of information between them to the host sites, but they were not responsible for developing the software, or "protocol", that would enable the IMPs to communicate with the computers at the host site (see figure 1.4). The host sites were responsible for that. To address this issue, graduate students from the first four host sites

---

[24] Ibid., 83-87.

convened to sculpt a strategy to develop the protocol that would enable the IMP to communicate with the host computers (the computer science field was so young at this point, graduate students were among the most qualified for the job). This became known as "host-to-host protocol."[25]

Figure 1.3. Bolt, Baranek and Newman's IMP team in 1969.

The first IMP was delivered to UCLA at the end of August of 1969. It is interesting to note that the final tweaking and delivery of the first IMP coincided with the first lunar landing. Both were events that ushered in a new age for Americans. Both symbolized revolutions in technology and science. But the American people only heard about one.[26] There had been great concern on behalf of BBN and UCLA regarding the shipment of the large machine across the country. They feared the machine would be

---

[25] Hafner 144-148.
[26] Segaller 90.

damaged and would arrive at the destination in a non-functioning state as it was not common practice to ship computers at the time. The trip was completed without problems, however, and the computer arrived safely into the hands of giddy graduate students, nervous engineers and skeptics of all kinds who were present for the initial test.[27] The IMP was powered on; they waited; and communication with the host computer was established. Despite all the skepticism, BBN had successfully attained its first goal, and had done it on time and within budget. Len Kleinrock, the computer engineer at UCLA, describes the monumentally important, yet obscurely commemorated event as follows:

> We had messages moving back and forth. Everybody was there. BBN was there. The computer science department was there. The school of engineering. UCLA administration. GTE was there. It was their machine. AT&T was there. It was their long lines network. Scientific Data Systems was there because our host machine was an SDS. Everybody was there and they were all ready to point the finger, right? If it didn't work. Fortunately, everybody had done their jobs very well. It worked beautifully. And there was a big celebration. But nobody had a camera. Nobody thought to memorialize this event. It just didn't seem like a big deal. You know, two machines talking to each other.[28]

The second IMP arrived at Stanford Research Institute about a month later. This was a particularly significant moment because with the two IMPs now in place, the true network of remote IMPs could be tested, rather than just testing the connection between the IMP and the host computer. When the machine was in place at SRI, the team at UCLA attempted to send them a message. This historic message consisted of nothing

---

[27] Hafner 150.
[28] Segaller 92.

more than the letters "L" and "O", but the important thing is that they were entered into a computer at UCLA and received by a computer at SRI.[29]

The third and fourth of the IMPs were delivered to UCSB and University of Utah over the following two months. With the delivery of the fourth IMP, BBN had successfully completed the first stage of the ARPANET construction--with four nodes (IMPs) communicating with one another from four host sites. It was this tiny network that laid the technological groundwork for a network that would eventually connect computers all over the world.

BBN continued to tweak the IMPs and to deliver them to the growing list of host sites. In March of 1970, the first cross-country connection in the network was put into place. It connected BBN's Cambridge office and UCLA's computer center. This connection was of particular significance both because of the distance it spanned and because of the work it saved. Before BBN became a node on the network, employees there spent an inordinate amount of time on the phone helping troubleshoot problems host sites were having with the IMP. When BBN became connected, they were able to send, via the network, large amounts of status reports and data to the sites electronically, thus increasing efficiency immensely.[30] By the summer of 1970, IMPs were installed at MIT, RAND, System Development Corporation, and Harvard. Approximately one node per month was being added to the network at this point.

In 1971, BBN began working on the Terminal IMP, or TIP. The existing IMPs could only handle up to 4 host interfaces, which greatly limited the amount of users the

---

[29] Ibid., 92-93.
[30] Hafner 161-162.

network could support. The Terminal IMP would allow dozens of simple computers to directly connect to the IMP, without having to go through the host computer. It would also handle a large amount of traffic created by many users connecting through a dial-up line. The machine was designed and constructed within six months. The significance of this advancement is immense—it meant that the network would now be accessible to those other than advanced computer scientists who had access to host computers. Anyone with a simple terminal device (akin to an early personal computer, but lacking its own processor) could connect.[31]

By 1973, thirty institutions were connected to the ARPANET. The success of the project had proven that packet-switching was a viable technology and subsequently other networks were developed by different entities, such as the National Science Foundation. BBN and others continued to work on both the ARPANET and other networking issues, including developing additional protocols to enable the linking of separate networks, most significantly TCP/IP.[32] This collection of networks became known as the "Internet" (see figure 1.5) and was made significantly more user-friendly with the invention of the World Wide Web in 1990 by Tim Berners-Lee. The World Wide Web, essentially, was software that "translates" material from any computer, from any format, into a common language of words, images and address.[33]

[31] Ibid., 172-174.
[32] Transmission Control Protocol/Internet Protocol—see glossary for definitions.
[33] Segaller 398.

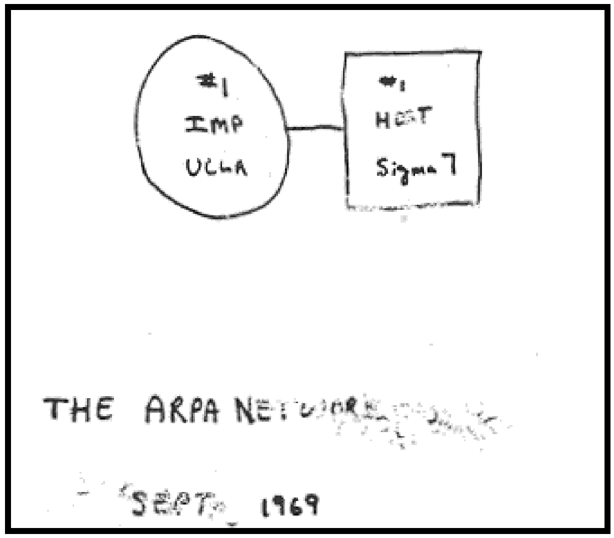


Figure 1.4. Sketch of first IMP-host computer connection at UCLA, 1969.
(Image courtesy of Computer History Museum)

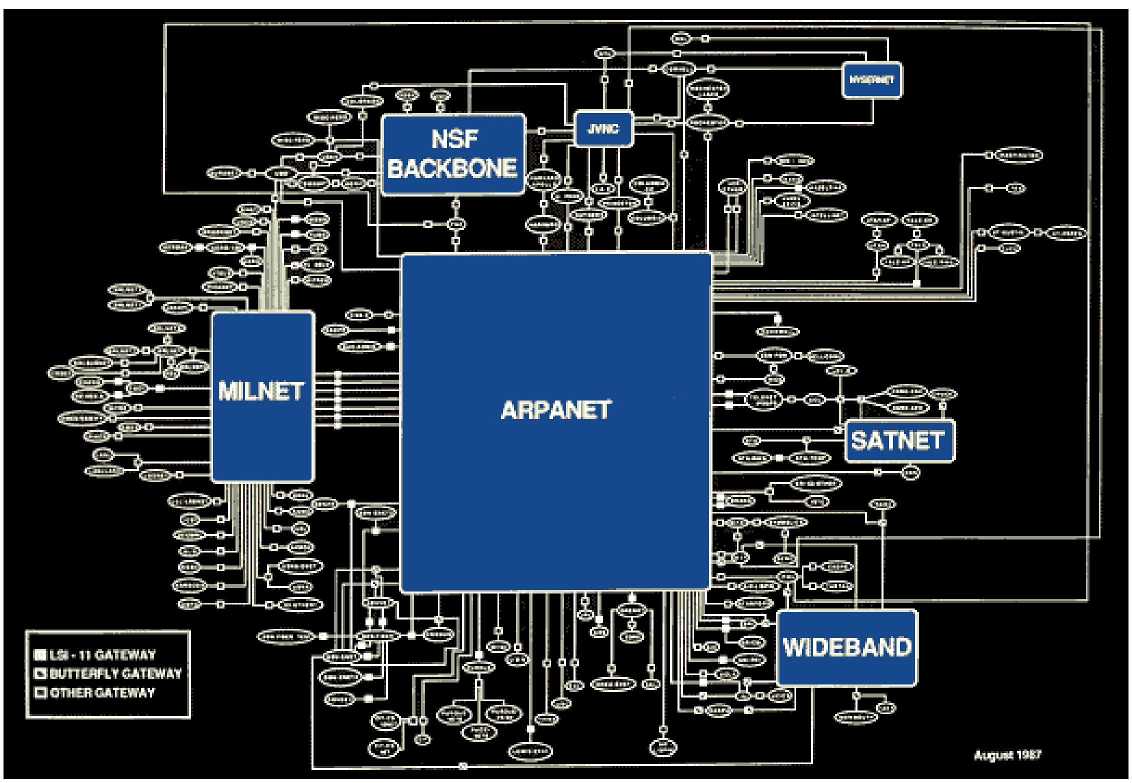


Figure 1.5. Collection of inter-connected networks that became known as the “Internet”, 1987.
(Image courtesy of www.cybergeography.org)

**Email**

BBN is arguably best known for the invention of email. The invention of email did not occur as many might expect. It was not an idea that was brilliantly conceived, deemed as a tool worthy of development, and then engineered by computer scientists. Rather, the concept of email seemed to have introduced itself to the networking community during the early days of network usage. It should be kept in mind that the ARPANET pioneers had no intention of designing the network to function as a message system. However, users of the network found that it was an extremely efficient vehicle for communicating brief messages amongst themselves.[34] Early mail programs had been developed in the 1960s, but they were for use only between local machines that were connected to one common mainframe computer.[35] Ray Tomlinson, an engineer at BBN, sent the first email message between two completely distinct computers in 1972 using an experimental file-transfer protocol called CPYNET.[36] In essence, he wrote a program that enabled electronic mail to be sent over the ARPANET. Tomlinson had another very significant contribution to the invention of email: he chose the "@" sign to serve as the separation between the sender's name and address. Little did he know how ubiquitous this sign would become.

---

[34] Hafner 189.
[35] Ibid., 189-190.
[36] Ibid., 191-192.

There is no need to document the overwhelming popularity and influence of email in the last decade. What is perhaps most striking about its success is that it was completely unexpected. The engineers in the Information Processing Techniques Office sent a report to ARPA in the late 1970s that expressed their own surprise regarding the issue:

> The largest single surprise of the ARPANET program has been the incredible popularity and success of network mail. There is little doubt that the techniques of network mail developed in connection with the ARPANET program are going to sweep the country and drastically change the techniques used for intercommunication in the public and private sectors.[37]

The road to today's Internet was long and complex. But as Katie Hafner points out, what matters most are not the details of how it was constructed, but rather the spirit that drove it:

> The romance of the Net came not from how it was built or how it worked but from how it was used. By 1980 the Net was far more than a collection of computers and leased lines. It was a place to share work and build friendships and a more open method of communication. America's romance with the highway system, by analogy, was created not so much by the first person who figured out how to grade a road made of blacktop or paint a stripe down the middle but by the person who discovered you could drive a convertible down Route 66 like James Dean and play your radio loud and have a great time.[38]

---

[37] Ibid., 214.
[38] Ibid., 218.

# CHAPTER 2

## CURRENT PRESERVATION AND INTERPRETATION OF TECHNOLOGICAL HISTORY

The significance of the work undertaken at Bolt, Beranek and Newman's Cambridge site makes it a worthy candidate for preservation and interpretation. Its position in history has been solidified as the birthplace of the ARPANET, the experimental network that gave rise to today's ubiquitous technological goliath, the Internet. Traditional methods of preservation and interpretation may not be adequate for this site, however, given that as an entity the Internet is comprised mainly of transparent connections and invisible packets of information rather than bricks and steel. The technology of the Internet is utterly invisible to the eye. We can see what the Internet enables us to do. We can see the words that we send across it, the web sites we access through it, and the computers with which we connect to it, but we cannot see the structure of the Internet itself. This is precisely what the creators of the ARPANET were striving for: a completely invisible system through which information could flow at speeds that were unperceivable to the users.

Additionally, much of the work that went into creating the network is also invisible, at least to the eyes of today's preservationists. The development of the technology that underlay the ARPANET comprised the writing of complicated code that served as instructions for the machines and of making minuscule adjustments of no visible consequence to the inner workings of complex hardware. Other than the large gray metal boxes that housed the hardware and a small collection of notes written in technical jargon, there is very little material to preserve and interpret. Additionally, the nondescript buildings on the site reflect make no suggestion of the extraordinary innovation that occurred within their wall. The majority of what exists to preserve and interpret at the BBN site is intangible, but no less important than traditional artifacts and material. Ideas, theories, strokes of genius, unusual personalities, determined persistence and the ultimate success of a project that revolutionized the world's relationship with information can all be found within the site.

As compared to more "traditional" historic sites, the preservation and interpretation of the BBN site and other Information Age sites will present new challenges due to their unique characteristics. While most historic sites have some elements of visual interest, the BBN site lacks great aesthetic appeal and is not yet fifty years old. This could inhibit the process of securing historic designation or recognition. In regard to interpretation, conventional exhibits are generally more artifact-focused than not. For lack of significant material objects on which to focus, the majority of the history of BBN and the ARPANET would have to be related through alternative interpretive methods. However, the basic principles of effective interpretation would still apply.

In order to acquire a better understanding of these issues, this chapter examines the preservation and interpretation efforts undertaken at existing technology and Information Age sites and interpretive programs. Historic sites comparable to the BBN site are first examined. Second, existing technological history exhibits are discussed. To the author's knowledge, there are no significant interpretive exhibits currently in place at any Information Age historic sites. Therefore, of the interpretive programs presented, one is an Industrial Revolution-era site with an extremely successful interpretive program; the second and third programs are Information Age history exhibits within traditional museums. Examining these two different types of interpretive programs provides a valuable comparison between the interpretive methods of a successful traditional interpretive program at a pre-Information Age technological history site and those methods employed within recently developed Information Age exhibits. In order to evaluate the effectiveness of the elements of the programs, they are analyzed within the framework of commonly accepted, general principles of successful interpretation. As a result of this analysis, the chapter concludes with an overview of methods, elements and characteristics that may be effective when applied to Information Age sites.

## Historic Designation

Identifying historic properties that are comparable to the BBN site is a challenging endeavor. Most sites associated with the computer and Information Age have yet to reach fifty years of age, the minimum age of an "historic property" as set forth by the National Register of Historic Places, and therefore still exist in obscurity in the netherworld of almost-historic sites. There is one state, however, that has plucked a couple of these sites from obscurity: California.

Both of the following sites are located in Palo Alto, California- the heart of the “Silicon Valley” area. Given the importance of the computer industry to the area's economic and cultural development, it should be of no surprise that they have both been given State Landmark status. The first site is a small, unassuming residential garage structure that sits adjacent to a private residence within a typical Palo Alto residential neighborhood (see figure 2.1). The structure was designated a landmark for being "the birthplace of Silicon Valley", earning this distinction for being the site where two Stanford graduates named Bill Hewlett and Dave Packard came together in 1939 to build what turned out to be the first of a long and still growing list of products produced by their company. The machine they built was an audio oscillator, and the company they formed is Hewlett Packard. The site was designated an historic landmark in 1980 and marked with a plaque. At that time the building was approximately 40 years old.[39]

The similarities between this and the BBN site are numerous. Most significantly, they are both sites where highly significant "firsts" occurred-- “firsts” that put trends into motion that had enormous impacts on the technological landscape of the United States. Secondly, both are located in unassuming structures that do not boast any particular significance or beauty on their own, or architectural connections to the work that was undertaken in them. Additionally, the invention of the audio oscillator at the Hewlett Packard site itself is not the direct reason for the site's significance; rather, the significance lies in the symbolism of the machine as the first of what would be a deluge of technological advancements in the area. Similarly, the ARPANET innovation alone is not of primary significance in regard to the BBN site; most significant is that it led to the Internet revolution.

[39] State of California, Department of Parks and Recreation, Office of Historic Preservation California, Historical Landmarks Guidebook (Sacramento 1995).

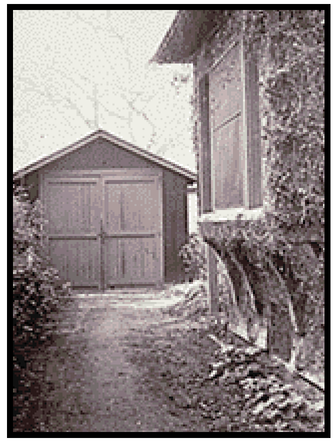

Figure 2.1. “Birthplace of Silicon Valley”, California State Landmark, Palo Alto, CA. (Photo courtesy of State of California Office of Historic Preservation)

The second site is also located in Palo Alto and is historically significant as the location where the “first commercially practicable integrated circuit” (or microchip) was invented in 1959. Developed by Dr. Robert Noyce of the Fairchild Semiconductor Corporation (later of Intel Corporation), the invention is described as a complete electronic circuit inside a small silicon chip that helped to revolutionize 'Silicon Valley's' semiconductor electronics industry, and brought profound change to the lives of people everywhere.[40] The site is now occupied by a furniture company and is marked with a plaque. The site was designated a state landmark in 1991, when the site was just over 30 years old.

Again, the characteristics of this site are very similar to those of the BBN site. Additionally, this case provides a valuable example of what might lay ahead for the BBN site should it not be afforded protection. This innovation occurred within a nondescript commercial building in a high area where property values are very high. When the

[40] Ibid.

Fairchild Semiconductor Corporation relocated, the property was leased to another commercial tenant, and over the years, the building has been altered significantly. Today, the site is occupied by a used furniture company, and is marked only by a small plaque.

It is of interest to note that at least one proposal was made for redevelopment of the site that would both upgrade the office space and preserve the history of the site. The following description of the proposed project, written by a Palo Alto architect, ran in *Palo Alto Weekly*'s online edition in 1996:

> At 844 E. Charleston Road, a small '50s-style office building near the intersection of East Charleston and San Antonio roads, a small bronze plaque commemorates the development of the first commercially practicable integrated circuit, or silicon chip.
>
> Greenmeadow Architects proposes that Palo Alto acknowledge its own significance with Ground Zero, a mixed-use development commemorating the historic center of the information revolution. Phase 1, at 844 E. Charleston itself, would be a tall, highly visible monument to mark the site and relieve the banality of Palo Alto's "South Gate." At the same time, the current building would be preserved as a reception building for a new Technology Demonstration Center.
>
> Phase 2 would distinguish the site with a Tech Dome and restore other existing small-scale gems of '50s California modernism. New infill buildings in the same aesthetic of expressive, honest structure would be added to vitalize the site. Environmentally-friendly materials and building-integrated photovoltaics would showcase the cutting edge of construction technology.[41]

This proposal highlights another viable option for some Information Age sites--incorporating original structures into commercial development projects that adaptively re-use existing structures and celebrate that history of the site. To the author's knowledge, no construction has been undertaken at the site to date.

---

[41] James McFall, "Ground Zero Proposal," Palo Alto Weekly (online edition) 1996.

**Interpretation**

The designation of these sites as state landmarks provides for increased notoriety for the sites and educates people on the history of the Palo Alto area. Virtually no interpretation is provided for the sites, however, which creates little opportunity for a deeper understanding of the event, its significance, and its impact on the larger community, state or nation. Innovative interpretive programs of Information Age technological history may be one of the most effective ways of fostering the preservation of sites such as these. Often lacking in notable architecture, beautiful geographic characteristics, or artifacts and other elements that can speak for themselves, these sites may benefit greatly from exhibits or other types of interpretive programming that can convey the historic significance and unseen beauty of the site.

This may be easier said than done, however. It is evident that the history of Bolt, Beranek and Newman and the ARPANET is replete with complicated engineering feats and "techie" lingo, and has few artifacts to illustrate its history (most of which are pieces of complicated machinery). This does not mean, however, that the history of the ARPANET *cannot* be preserved and interpreted and done in a way that would make it of interest to a wide array of people. Rather, by examining effective methods of interpretation, and adapting them to suit the nature of Information Age technological history, developing a successful interpretive program that would convey the significance of the site and the innovation in a way that appeals to different types of people (and not just technophiles) is possible. This can be accomplished through effective interpretative programs that may inspire, provoke, enlighten and entertain visitors.

The concept of interpretation, as used in this case, refers to the way in which historic or cultural resources are presented to visitors in order to convey information. Interpretation can take the form of a museum exhibit, a guided tour, a label next to an artifact, a theatrical presentation, an interactive computer program, or a publication, to name just a few examples. There are many definitions of interpretation, most of which are very similar, but some have slight philosophical differences which should not be dismissed. Two definitions are offered here in order to provide insight into the differing theoretical approaches to the process.

Freeman Tilden's definition in his seminal book, *Interpreting our Heritage*, is eloquent and poetic as he describes interpreters as being "engaged in the work of revealing, to such visitors as desire the service, something of the beauty and wonder, the inspiration and spiritual meaning that lie behind what the visitor can with his senses perceive."[42] The National Park Service puts forth a definition that is significantly more practical in tone. Interpretation, according to the NPS, is defined with three tenets, which are: 1) "Historic resources possess meanings and have significance"; 2) "The visitor is seeking something of value for themselves"; and 3) "Interpretation, then, facilitates a connection between interests of the visitor and the meanings of the resource."[43] Interpretation, therefore, has both a practical purpose--that of fulfilling the visitors needs by relating the resources and the history to their lives or personalities, and a purpose that is more romantic in nature--that of encouraging visitors to see beyond the material objects; to embrace the beauty and spirit that lay within them; to inspire.

---

[42] Freeman Tilden, Interpreting our Heritage (Chapel Hill: University of North Carolina Press, 1977), 3.
[43] United States, Dept. of the Interior, National Park Service, Telling the Stories: Planning Effective Interpretive Programs for Properties Listed in the National Register of Historic Places (Washington: GPO, 2000).

There is no magic formula for creating successful interpretive programs. There are, however, commonly accepted principles that serve as guidelines when developing or evaluating interpretive programs. In their book, *Interpretation for the 21st Century*, Larry Beck and Ted Cable offer fifteen guiding principles for effective interpretation[44]. While these principles are neither steadfast nor universal, many are mainstays in the realm of interpretive philosophy. Four of the principles most relevant to interpretation of technological history are summarized here:

1. In order for interpretation to be effective, it must relate the subject to the life of the visitor; otherwise, the visitor's interest will not be sustained.
2. Interpretation should present complete themes rather than disparate pieces of information.
3. Interpretation is essentially a work of art, going beyond providing information to reveal a deeper meaning and truth, by telling a story that entertains and enlightens. The goal of this is to inspire visitors to broaden their horizons.
4. Interpreters must take care not to sacrifice quality for quantity. Fewer artifacts and deeper interpretation is more effective.[45]

These principles provide criteria for the evaluation of the following technological history interpretive programs. A particular focus is given to the first two principles as they are of paramount significance for successful interpretation of technological history. Because of its impersonal and complicated nature, it can be extremely difficult to relate

[44] Beck and Cable's first six principles are re-workings of Freeman Tilden's original six principles written in *Interpreting our Heritage*.
[45] Beck and Cable 10.

the topic to the lives of visitors and to create a relevant and compelling experience for them. With few artifacts and resources with overt meaning to present to visitors, people who do not possess a basic understanding of the given subject may lose interest quickly and feel alienated within such an exhibit. In regard to the second principle, technological history interpretive programs are more likely to succeed in relating the topic to the lives of the visitors if the information is presented within themes that encompass larger issues and universal human interests. These themes could relate to the social, cultural, political and economic impacts of a technology.

## Case Study #1: Lowell National Historical Park

### *Background*

Located in Lowell, Massachusetts, Lowell National Historical Park is one of the best known and most heavily visited technological history sites in the country. An excellent example of an Industrial Revolution-era mill town, it was designated a National Park in 1978 after citizens and local politicians mobilized to preserve the city's historic resources and to create a historic attraction that would financially benefit the declining city. The planners of the park had an extensive amount of resources and space with which to work, including textile mills, historic machinery, workers' housing, an historic canal system, and additional related buildings and artifacts.

***Description of Interpretive Program***[46]

Most people begin their Lowell experience at the Park's visitor center, a restored mill building, which features a small, traditional museum exhibit consisting of various artifacts associated with the mills, such as finished textiles and small pieces of machinery, in addition to informational panels utilizing text and images to provide information about the founders of Lowell, the workers, the labor issues and the rise and fall of the great mill town. Visitors are also invited to view a ten-minute introductory slide show that provides an overview of the park's history and interpretive program. Park rangers are present in the Visitor Center to provide information and answer questions.

Across the park, the Boott Cotton Mills Museum (figure 2.2) is the park's largest and most popular exhibit. Also housed within a restored mill building, the first floor of the museum features a weave room with operating power looms dating from the 1920s that roar and bang as visitors look on (see figure 2.3). The looms produce textiles akin to those manufactured at the mill in the first decades of the twentieth century, and interpretive staff is on hand to discuss the workings and technology of the machines, in addition to the providing descriptions of the challenging working environment faced by the mill's laborers.

On the second floor of Boot Cotton Mill is a traditional museum exhibit that surveys the history of Lowell chronologically from its founding through the present day (figure 2.4). A majority of the interpretive elements are artifact displays, such as machinery and tools, textiles, and clothing with accompanying labels and information.

---

[46] Given the extensive amount of exhibits and resources, it is impossible to cover all of the park's interpretive elements here, and therefore, the elements of a few key exhibits are discussed.

Other displays include numerous re-creations of rooms and locations with mannequins "in action", video loops of interviews with mill employees and residents of the town, audio narration of letters written by “mill girls” " (the New England area women who left their farms to come work at Lowell’s mills for the promise of good money and city life) and decrees penned by the mill managers, and several interactive exhibits. Interactive multimedia kiosks that enable visitors to "become involved" in political debates regarding labor issues by pushing buttons to hear and see politicians with different points of view deliver speeches aimed at one another (figure 2.5), and less technologically advanced interactive displays such as those that allow visitors to comb cotton used to manufacture textiles (figure 2.6) are a few examples of the interactive exhibits.

There is only one exhibit within the park that focuses specifically on the technological history at Lowell: the Suffolk Mill Turbine Exhibit. This exhibit allows visitors to see up-close how a turbine engine generates energy. Located next to a thirteen-foot drop in a canal, visitors watch the water drive a turbine and subsequently power a working loom representative of the hundreds of looms operating at the height of Lowell’s manufacturing (see figure 2.7).

Figure 2.2. Lowell’s Boott Cotton Mills Museum exterior.

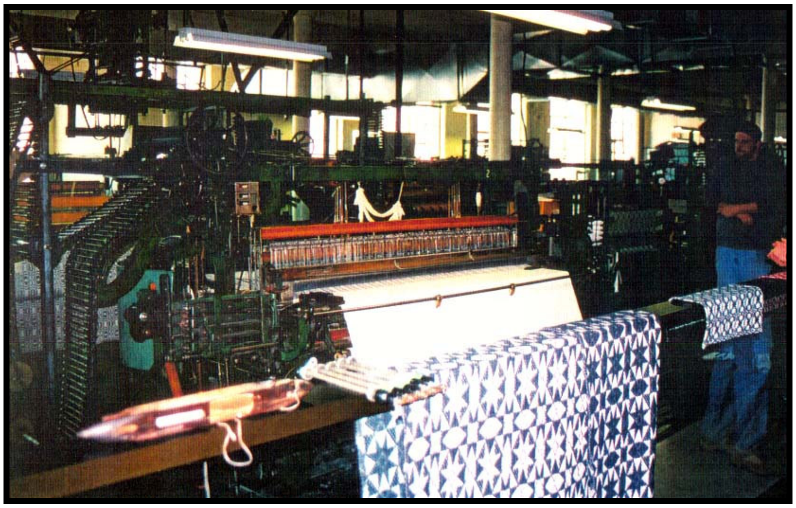

Figure 2.3.  Lowell's weave room exhibit.

Figure 2.4.  Lowell's Boott Cotton Mills Museum main exhibit.

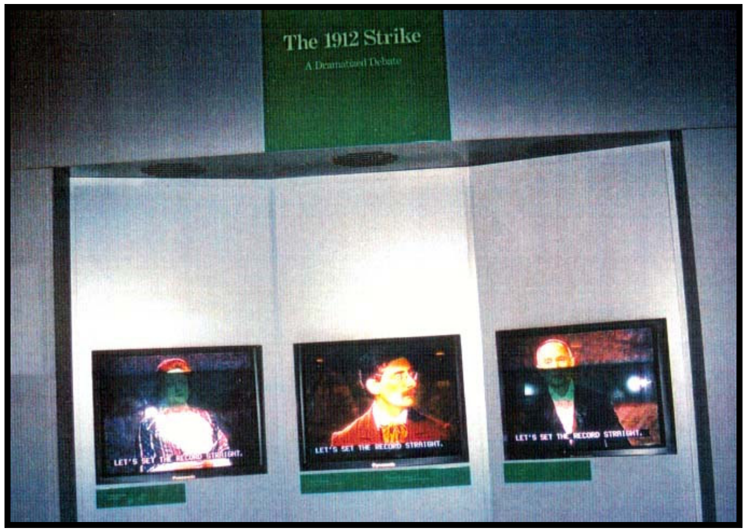


Figure 2.5. Lowell's interactive political debate display.


Figure 2.6. Lowell's interactive display that allows visitors to comb cotton.

Figure 2.7. Lowell's Suffolk Mill turbine exhibit.

Figure 2.8. Lowell's restored boardinghouses.

Other options for the Lowell visitor include a guided tour by boat through the canal and lock system of Lowell and a restored boarding house similar to those inhabited by the mill girls (figure 2.8). Costumed interpreters guide visitors through the house and provide insight into the daily lives and living conditions of these unlikely factory workers. There is also a textile museum dedicated to the universal art of textile manufacturing.

***Analysis***

Lowell's interpretive program accomplishes the first principle of effective interpretation by relating the historic resources and information to the lives of the visitor. At the beginning of the visit, the slideshow initiates a type of dialogue with the visitor by presenting an outline of what they are about to encounter at the site. This provides visitors with the opportunity to decide which subjects and attractions at the site are of the most importance and interest to them before venturing out on their own into the sea of exhibits, buildings, boats and trains. The park is too expansive to be covered in one average visit; and the information from the slide show and visitor center establish a type of dialogue with visitors that empowers them to choose what they want to focus on during their visit. This is an extremely important element because, as Freeman Tilden pointed out, visitors do not want to be talked at, but rather, talked *with*.[47]

At the Boott Cotton Mills Museum, various elements of the exhibits also achieve this goal. The weave room exhibit is highly effective in translating the essence of the mill workers' daily lives. The noise produced by the machines is deafening, and their violent movements that maimed many workers are plain to see. Visitors experience an

[47] Tilden 12.

environment akin to that of the mill workers by hearing, seeing and touching the objects and machinery, while interpreters running the machines tell stories of mill girls who worked the machines for often as many as eighteen hours a day.

Upstairs in the main history exhibit, displays go beyond artifacts and labels to connect with the visitor. The interactive exhibits, video shorts and audio tapes of mill workers' letters tinged with homesickness and frustration at working conditions may engage visitors and facilitate an emotional or intellectual connection with the experience of the workers. Re-creations of typical Lowell scenes utilizing mannequins and artifacts also attempt to connect directly to the lives of the visitor by giving them a "window" into the past and the opportunity to feel as though they are witnessing the history for themselves.

Another attraction that is highly effective at connecting with visitors is the turbine exhibit. This is a compelling attraction that allows visitors to see the equipment in action and to comprehend a technology that may have been foreign to them before. It is possible that witnessing the workings of the turbine will make one consider how the importance of waterpower dictated the locations of mills, and therefore, the industrial landscape of America. Or perhaps it provokes one to ponder the comparative difference between this type of energy source and the one that powers their big screen, surround sound, home entertainment system. Either way, to witness the workings of the turbine in its original location gives visitors the opportunity to connect with the subject, step back in time, and have their imaginations ignited.

The interpretive programming at Lowell presents the information to visitors within larger themes, rather than in disparate details, as is put forth in the second principle of effective interpretation. This is of particular significance when dealing with technological history given that the impacts of technology rather than the details of technology itself are often of greater interest to visitors. For example, learning about the nuts and bolts of the internal combustion engine might be compelling to a small amount of enthusiasts, but it can be assumed that a greater number of people would prefer to know how daily lives were affected when automobiles first hit the roads. Visitors would be more curious to know what people thought about these amazing horseless carriages and how their experiences with cars were different than ours' today than about the details of cylinders and horsepower.

Four main themes are presented through the interpretation at Lowell. The first theme is *the rise of Lowell* as an industrial city. This theme tells the stories of the Yankee capitalists who traveled to Britain to learn the technology of textile weaving and returned to Massachusetts to build factories, such as Lowell, along the state's rivers. The second theme conveyed to the visitors is that of *labor issues* at the Lowell textile mills, beginning with the stories of the famous mill girls and the problems surrounding working conditions and wages. The third theme encompasses the next wave of laborers, the *immigrants,* who came in droves to work at the mills and how these different ethnic groups settled in the city and interacted with one another. The last theme focuses on the great *prosperity and subsequent decline* of the Lowell mills. The themes of the interpretive program at Lowell are universal in nature and appeal to a wide array of people and interests as within them lay the age-old topics of risk-taking, success, failure, the promise of a better future, and the fight for fair treatment-all topics to which people relate to their own lives.

Ralph Waldo Emerson said: "Truly speaking, it is not instruction but provocation that I can receive from another soul."[48] If this is true for everyone, then the third principle of effective interpretation is an essential element of any interpretive program that hopes to educate visitors. The principle states that interpretation should not be considered as just a vehicle for conveying history and information, but as a work of art that, when experienced by visitors, shows them a greater truth or beauty. This type of interpretation serves to provoke visitors to want to learn for themselves, rather than to simply feed them dry facts and details.

Whether or not this is accomplished at Lowell is probably more a subjective opinion than fact. However, it is certain that the park's interpretation attempts to provoke its visitors through various elements. Through themes and stories, the boarding houses and the weave rooms, and various displays, the exhibits strive to convey the essence of Lowell. The boldness of Yankee ingenuity, a farm girl's dreams of sophisticated city living in Lowell, the brutality of eighteen-hour workdays, and the power of people when they come together in protest: therein lays the beauty, the greater truth and the spirit of Lowell.

To inspire visitors, the planners of the Lowell park brought the history of the site to life by utilizing the historic resources that had the most potential to animate the park and to provide visitors with an experience akin to stepping back in time. The functioning looms in the weave room bring to life the workers conditions. The turbine powering the loom brings to life the mills' energy source in a way that makes it easy for visitors to understand. Riding a boat through the park's canals and locks breathes life into the larger

[48] Tilden 33.

operations of the park, and reconstructed boarding houses evoke a feeling of having shared an experience with the workers. All of the historic resources are utilized in an effective manner to optimize visitor experience--to recreate the environment of nineteenth-century Lowell through the functioning machinery and mill operations, and recreating the laborers' working conditions and bringing to life the personalities of those who lived there.

In regard to the last interpretive principle, the majority of the park's exhibits do not sacrifice quality for quantity. Unlike many traditional museum exhibits, Lowell's artifact displays do not feature an overabundance of similar artifacts. For example, the Boott Cotton Mills Museum exhibit could have displayed dozens upon dozens of textiles akin to those manufactured at the Lowell mills. Rather, the visitors encounter only select samples that are excellent representations of the mills' products. The artifacts that are displayed throughout the park appear to be carefully chosen through a critical decision making process.

## Case Study #2: National Museum of American History

### *Background*

The *Information Age: People, Information and Technology* exhibition at the National Museum of American History of the Smithsonian Institution presents a comprehensive survey of the history of information technology. Opened in 1990, the exhibition is comprised primarily of objects from the Smithsonian Institution's Computer History Collection and covers information technology history from the telegraph to the present. This exhibition is one of the most comprehensive and respected technological history exhibitions in the country.

***Interpretive Program***

On the first floor of the museum, *Information Age: People, Information and Technology* can be found amidst other American history exhibits such as *First Ladies* and *American Maritime Enterprise*. Located at the entrance of the exhibition area is a revolving display of full-size, cartoon-like models of people in various comical situations involving technology (see figure 2.9). There is a man kicking an ATM machine, an exasperated administrative worker who is simultaneously on the computer, the telephone, and the fax machine, and a nerdy tourist with a video camera eagerly filming away. Stepping into the exhibition proper, visitors encounter a chronologically arranged sequence of specific technology displays that begin with the telegraph and end with cutting-edge research and projects in information technology. An extensive amount of artifacts and objects abound throughout the exhibition, including numerous machines and photographs- most with traditional labeling and information panels for interpretation. Each chronological section focuses on a specific type or class of technology which then flows into the next section with a description of what conditions gave rise to, or served as the inspiration for the subsequent technological innovation.

Breaking up the standard format of artifact display and description are stage set-like recreations of historic events. For example, following the telegraph/telephone section of the exhibition is a large and elaborate display that depicts a nineteenth-century parade. The celebration, one learns, was to honor of the completion of first telegraph line connecting the United States and Great Britain. The set depicts people rejoicing in a city street lined with buildings as an audio component plays music and the sounds of the crowd cheering. Following the parade display is a mock “Main Street” display (see figure 2.10). Visitors walk "down the street" and pass by storefronts of various businesses, including a telephone company, flower shop, and a telegraph company displaying a “closed” sign to represent the demise of the telegraph after the advent of the telephone.

Figure 2.9. National Museum of American History Exhibit entrance display

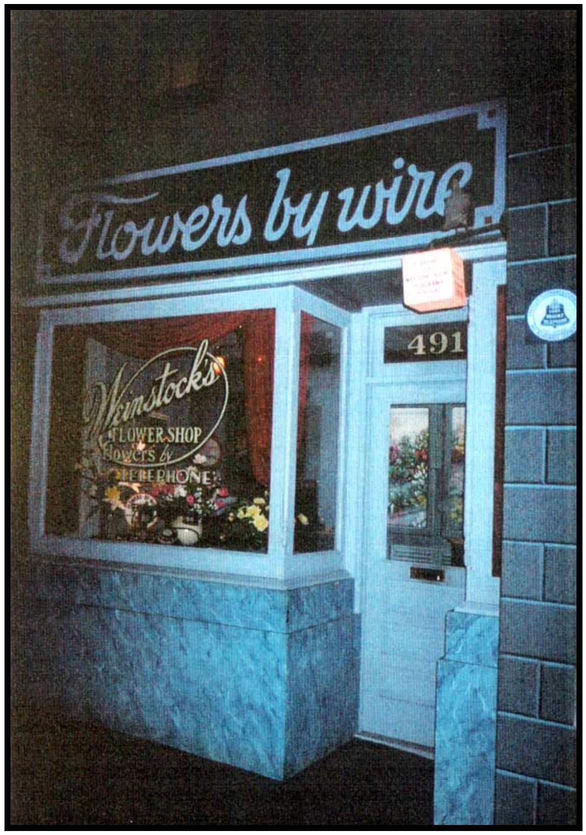


Figure 2.10. National Museum of American History “Main Street” display.

These are several other innovative interpretive elements within the exhibition, including video kiosks stationed throughout the exhibition that feature short videos ranging from historic news briefings to first hand descriptions of how a technology works from the inventor himself. Visitors activate the videos with a push of a button. Of particular interest, several are clips from comedic television shows and movies, such as “Abbott and Costello Meet the Telephone”--a farcical display of how technology can go awry. Throughout the exhibition, audiovisual components such as these augment computer and other technology artifact displays, often featuring video loops of inventors speaking about the artifact, or a promotional commercial from the company that manufactured and marketed the product.

***Conclusions***

Many of the interpretive elements within the exhibition are specifically geared towards creating a connection between the subject and the lives of the visitors. The first revolving display outside of the exhibition is the most obvious attempt to provoke visitors to relate the subject to their own lives before they even step foot into the exhibition. The display begs the questions, “Does technology sometimes drive *you* crazy? Are technological advances always for the better? How does technology affect the world and our lives?” Ideally as a result of this display, visitors will enter the exhibit with a temporary emotional connection to the subject of technology and in turn experience the exhibition in a way that is more meaningful to them. This display also succeeds in lightening up the topic of technology and perhaps reducing feelings of intimidation individuals may have about the subject.

The language of technology is often complicated jargon, which can be either incomprehensible or uninteresting to the average person. This exhibition seems to create a "language" with which to speak to its visitors so that they may understand and relate to the information. This language is comprised of human experiences as relayed through displays such as the telegraph celebration parade and "Main Street". Television news reports announcing technological advances from the relevant era, magazine covers offering social commentary on given technologies and their implications, and radio broadcasts tell the stories of the people and the impact the technologies had on their lives, their emotions, and their senses of security (see figure 2.11).


Figure 2.11. National Museum of American History Time magazine cover--included in a display that highlights the link between the threat of nuclear attack and the development of technology.

The interpretive programming in the exhibit aims to present the history of information technology through coherent themes. The museum's literature clearly defines the exhibition's main theme as "the technical evolution of electrical and information technology", but then goes on to qualify this statement by providing sub-themes:

> Although the exhibition is built around this technical theme, its emphasis is as much on social as technical change. The transformations in information technology came in a context of social forces such as business, politics, wars, and consumer interests. The exhibition highlights the interaction between these social forces and the development of information technology.[49]

Given the breadth of time, technology and change covered in the exhibition, this is an ambitious goal and the themes are not clearly conveyed due to the overwhelming amount of information presented.

---

[49] Smithsonian Institution, National Museum of American History, "*Information Age: People, Information and Technology Exhibition*", from http://americanhistory.si.edu/youmus/ex18infa.htm.

The Smithsonian is world-renowned for its extensive collections and exceptionally high quality exhibitions. Visitors spend days lost within its museums, soaking in the information and the history of exhibits and gawking at its remarkable collection of artifacts. It can be assumed that many visitors leave the Smithsonian museums with a sense of inspiration and a feeling that, even if for just a moment, their horizons were broadened beyond their daily routines and experiences. Perhaps they feel a sense of pride as an American or an increased respect for American culture as a foreigner (or perhaps seeing Archie Bunker's chair behind glass could have the opposite effect). The *Information Age* exhibition may not provoke this type of response in many people. While several of the elements within the exhibition work to relate the information to visitors' lives, the overall presentation fails to convey a larger picture and meaningful experience. The artifacts themselves, such as pieces of supercomputers, World War II code breakers, telegraphs, telephones, televisions and radios remain remote and distant without artful interpretation that inspires or provokes visitors to think about the impact of the objects, or about how the objects have affected their own lives (see figure 2.12).

Additionally, the strict chronological organization of the exhibit requires that the displays be viewed in sequential order. This can inhibit visitors' experiences by limiting their ability to move through the exhibit in a way that is most meaningful to them. As John Falk and Lynn Dierking point out in *The Museum Experience,* "The most effective exhibitions do not have to be viewed in sequential order- you can't depend on people to do that. They should be able to pick and choose what they want out of the exhibit and 'create their own experience'."[50]

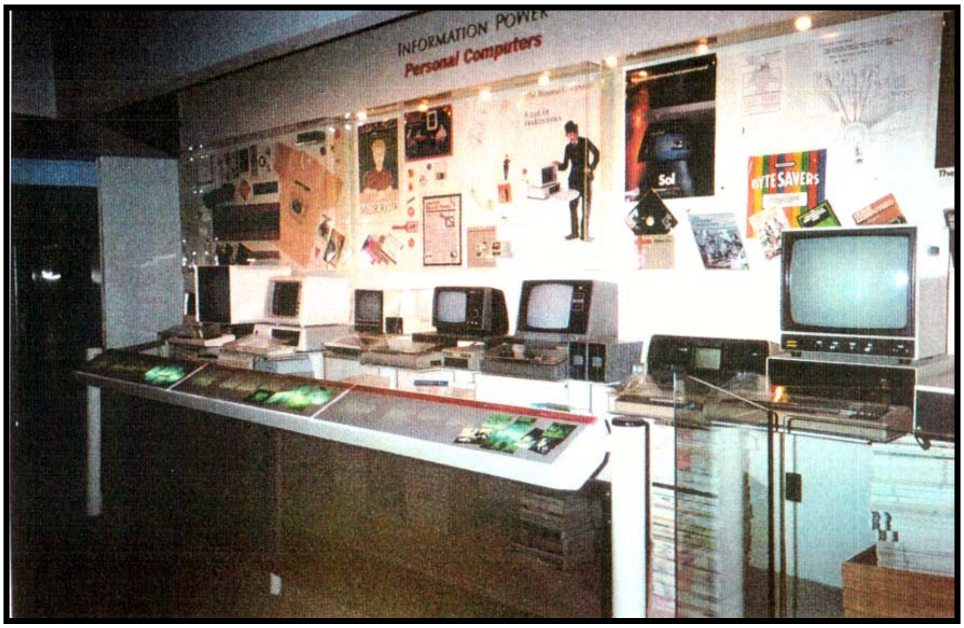


Figure 2.12. National Museum of American History computer machine display.

The superfluity of artifacts in this exhibit has already been mentioned. However, it must be kept in mind that this exhibition was designed to be a survey of the history of information technology in the United States. And although traditional principles of interpretation put forth that fewer artifacts with deeper interpretation is more effective, than vice-versa, the principle may have been intentionally disregarded in this instance in order to provide the greatest amount of information and artifacts on the subject at possible.

[50] John H. Falk and Lynn D. Dierking, The Museum Experience (Washington, DC: Whalesback Books,

**Case Study #3: Museum of Science**

***Background***

The Museum of Science (MOS), located in Boston, Massachusetts is the most heavily visited museum in the state with an average of one and a half million visitors per year. The museum is known for high quality exhibits that are educational, compelling, interactive and entertaining for visitors of all ages. Among the permanent exhibits are: the *Theater of Electricity*, an *Omni* movie theater, and the hands-on *Discovery Center*. The museum's newest permanent exhibit is *Computing Revolution*, an exhibit dedicated to the history of computing technology.

MOS had not planned to add an exhibit of this nature to their programming, but a merger with the Boston Computer Museum in 1999 presented the opportunity to do so. As a result of the merger, MOS committed to designing and installing a permanent exhibit that would focus on the history of computing technology and display the extensive collection of computer artifacts that they inherited from the Computer Museum. Being a *science* museum, the MOS exhibit planners were not accustomed to developing history exhibits, but they were very familiar with designing exhibits that inspire people to learn about technology.

***Interpretive Program***

A relatively small exhibit covering approximately 1,200 square feet, *Computing Revolution* comprises six general computing history theme areas, including computer prehistory, World War Two, business machines, personal computers, the Internet, and the

---

1992) 68.

twenty-first century. The sections are presented in chronological order and within each is an introductory section that provides the historical, social and technological context for the era, using narratives and artifacts. An important artifact or group of artifacts anchors every section.[51] For example, central to the business machines section are several pieces of the UNIVAC computer- the first computer to be sold to businesses in the United States. Other objects are included in this section, but the UNIVAC is central for being one of the most influential machines in the field.

Artifacts are clearly the main focus of the exhibit, as was stipulated in the agreement with the Computer Museum. Few artifacts are displayed with just a traditional label, however, and most are enhanced with audio-visual accompaniment for added interpretation. This is visible in the Whirlwind computer display. The museum possessed a large section of the enormous and nonfunctional supercomputer that most people probably couldn't even identify as a computer. In order to relate the story of the Whirlwind to visitors, film and video footage of personal interviews with people who worked on it are featured in tandem with the artifact itself. Other artifacts include the computer used to guide the Apollo in its space mission and an example of the first Apple Macintosh computer.

More than is seen in the previous case studies, interactive displays play a major role in the exhibit. Planners added freestanding exhibits amidst the chronological displays that may be accessed in any order and feature at least one interactive activity. Examples of displays include a computer terminal where visitors can pull up accounts of when computers have "gone bad", ranging from famous cases involving NASA to personal accounts of disastrous computer crashes added by other visitors, as that is an option as well. The most popular interactive display in the exhibit is called "Ride the Byte" which attempts to convey the extensive and expansive nature of the Internet to visitors (figure 2.13). At the display kiosk, visitors select a website of another museum or institution somewhere in the world from a small menu, a three-dimensional globe appears on a large screen in front of them, and visitors watch as the "packet" travels across the globe, from the museum, through servers, to the final destination. The visitor is then connected to the chosen website.

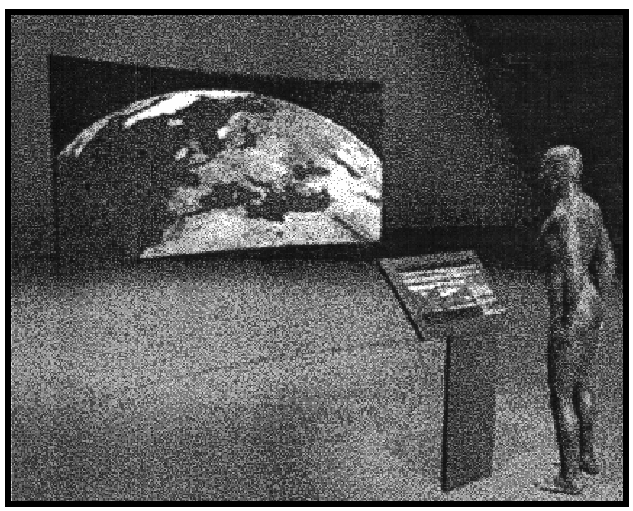

Figure 2.13. Museum of Science conceptual rendering of the "Ride the Byte" display. (Image courtesy of the Museum of Science)

[51] Ed Rodley, personal interview, 14 Jan. 2003.

***Conclusions***

Ed Rodley, the *Computing Revolution* exhibit planner was able to provide a great amount of insight into the primary goals of the exhibit and the subsequent design process. The exhibit planning process began with a formative evaluation phase during which MOS visitors were surveyed for their feedback regarding the subject of computers and computer history. The survey demonstrated that most people felt they had little to no knowledge of the history and inner workings of computers. The planners inferred from this that focusing directly on the technology behind computing was not an optimal theme for the exhibit. Second, the survey respondents expressed that if they were to visit such an exhibit, they would be less interested in the history of computing than in other subjects, such as how to protect yourself from various privacy and technological hazards. From this information, the planners decided they were facing a formidable challenge in designing an exhibit that would convey the history of computing (as they were required to do) while also offering other relevant information to relate the subject to the lives of the visitors.[52]

The planners resolved that conveying the excitement and significance of these technologies to the visitors should be the goal of the exhibit, and that the best way to accomplish this goal would be to focus first on stories and second on technological details. In the completed exhibit, interviews with individuals who worked with the historic machines or on the featured projects relate the history of the subject through looping video, and footage of people working on current projects at MIT and other institutions provides visitors with a window into cutting edge projects. In order to relate

[52] Ibid.

the technical information directly to the experiences of the visitors, all computing machines on display are labeled with statistics that compare the operations of that specific computer, in regard to memory, speed and power consumption to that of a personal computer in 2000, which most visitors have used themselves.

During the planning stage of the exhibit, planners established several themes to serve as the focus of the exhibit. The history of computing technology was to be the central theme, but additional themes were developed in order to enhance the visitor's experience by adding layers of meaning and opportunities for personal connection. In order to convey the history alongside these universal themes, the interpretation would present historic examples relevant to each theme. The themes include: how do new technologies change our world? Can we predict the impact of new technologies? What are the costs and benefits of new technologies? And are they worth it? To enhance the focus of these themes, the exhibit planners resolved to avoid the distant "museum voice" and to present the information from points of various points of view that underscored the themes. Three general viewpoints come across through the labels and other interpretive elements for the artifacts, including the engineer who asks, "what is the problem and how can we solve it?"; the conservative who asks, "why do we need a new computer to do something that we've always done before?"; and the informed citizen who asks "what are the pros and cons of this new technology and how will it change my life?"[53] Overall, the themes enhance the topic of technological history by focusing primarily on how technology affects our lives directly.

---

[53] Ibid.

The *Computing Revolution* makes strong attempts to broaden the horizons of visitors and to inspire them to think about technology in a new way. This is one of the basic tenants of the museum's approach to interpretation and the exhibit planners and designers are familiar with creating exhibits and displays that teach visitors in a way that is interactive, relevant and effective. Through hands-on and innovative activities, the museum achieves the goal of enabling visitors to experience technology and science in new ways that often provide them with a new perception and deeper understanding of the subject. One example of this in the *Computing Revolution* is the "Ride the Byte" display. This is a highly effective display that conveys fundamental information regarding the technology of the Internet, but does it in a way that allows the visitor to witness and experience the technology first hand, rather than reading about it, or looking at a metal box that houses the nuts and bolts. Visitors may immediately comprehend the breadth of the Internet and feel awestruck at its conceptual simplicity, inspiring them to picture that globe every time they log onto the Internet or send an email. This is a perfect example of interpretation that reveals a deeper meaning and can change the way visitors think.

Other displays that accomplish this goal include the "how does a hard disk drive work?" exhibit. This activity enables visitors to see how information is stored on a hard disk drive through the use of "the world's slowest, lowest-capacity hard disk drive". Visitors enter information into the machine and watch how it is stored onto the drive. The display brings the technology down to its most simplistic level and presents in an interactive manner that clearly conveys the underlying technology of a hard drive.[54] This

[54] Ibid.

type of understanding can completely alter the way that visitors will subsequently perceive the functioning of a computer through demystifying this technology.

The exhibit planners decided early on in the planning process that in order for this exhibit to be a success, it was very important that the exhibit should not *look like* a computer exhibit. This meant displaying fewer artifacts and providing deeper interpretation. With less focus on objects, the planners had greater room to develop interactive displays that would provide the visitor with an innovative means of learning and experiencing the subject matter. One feels that the artifacts that are displayed in the exhibit are on display because of their great significance and relevance, and not just because the objects were there for the taking. This is an excellent example of selective display of artifacts that results in an optimum visitor experience.

**Summary Conclusion**

Current methods employed in the preservation and interpretation of Information Age sites and resources do not vary dramatically from traditional methods. However, additional considerations must be given to these current methods to compensate for the unique nature of these sites and resources. Alterations in traditional methods may be required in order to achieve effective and successful preservation and interpretation. As seen in the case studies, some of the basic methods and approaches commonly utilized to preserve the history of a site or a technology are effective and successful when applied to the history of information technology. Others, however, are not appropriate applications to the ethereal and technologically complex nature of the Information Age.

Acquiring historic designation for historic Information Age sites is a viable option for the preservation of their history. It may be necessary, however, to alter the approach taken when determining the sites' significance. The site may possess little or no architectural significance and have a dearth of resources of interest that directly reflect the historic event which occurred there, and therefore, the site's essential significance may be questioned. This requires a greater emphasis put on the importance of the event and its relation to larger technological trends. As seen with both the Hewlett Packard garage and the site where the first microchip was developed, the historic significance of the site is expanded beyond the initial event to include its long-term impact on both technology and the surrounding area. All of these sites, including the Bolt, Beranek and Newman site, have greatly influenced economic and cultural development in their respective areas. One of the essential elements of technology is that it very rarely occurs in a vacuum. Rather, it builds upon work that was done in the past and influences work that is done in the future. These are the connections that should be focused on in regard to the site's significance.

The historic value of the site itself should be critically assessed. It is possible that it would be inappropriate for some Information Age sites to be protected from any major alterations or development in the future. This would not be the case if the site has the potential to convey important information about the historic era, event or subject. However, if the site itself has no significance, whatsoever, other than as the site of the given event, allowing the site to be developed in a way that highlighted and preserved the history of the site through creative design may be the most effective manner of preserving the site's history and conveying it to the public. This approach could allow the site to continue to function as a commercial site, ideally as a home to technology companies, while also providing the opportunity for interpretive programming of the site. The proposal to develop the site of the first microchip in Palo Alto is an excellent example of a possible approach to this type of project. This would also be in keeping with the forward-moving, progressive nature of technology itself. A technological "time-capsule" approach to a site's preservation would only be applicable to a site that physically represents and conveys the history of the site.

The approach to interpretation of Information Age sites and resources also requires major consideration. Information Age technology exhibits may differ tremendously from traditional technology and other history exhibits, such as Lowell National Historical Park, due to the lack of extensive and noteworthy artifacts with which to display. Lowell's great success is derived from the site's rich resources and subsequent ability to bring the site's history to life.

Traditional interpretive exhibits such as Lowell's are artifact-focused, whereas Information Age technology exhibits put greater emphasis on ideas and concepts. In order to avoid an overabundance of machines that may alienate many visitors, as seen in the *Information Age* exhibit at the National Museum of American History, artifacts that are displayed in these exhibits must be chosen carefully, ensuring that they are significant and can contribute to the visitor's experience. Additionally, non-functioning machine artifacts should be animated whenever possible through the use of multimedia enhancement, including video interviews and audio programs that can personalize the history surrounding the seemingly lifeless artifact.

The use of interactive exhibits is also extremely important in these types of exhibits. A lesson can be learned from science museums such as the Museum of Science where hands-on activities are among the most commonly used interpretive elements. The underpinnings of a technology can be very difficult to grasp for some and very uninteresting to others. Hands-on displays that allow visitors to participate in an engaging activity that relates the workings of a technology is a highly effective way to inspire visitors to learn.

Another important characteristic of Information Age interpretive programs is taken directly from traditional principles of effective interpretation: thematic presentation. Presenting the information of an interpretive program through themes is essential to the visitor experience. Particularly important in regard to information technology history which can be foreign to many visitors, developing themes that put the technology in context with the larger world is pivotal to facilitating a connection between the visitor and the information. These themes should be universal in nature and, if possible, tell something of "the great human story"[55].

Lastly, interpretive programming of Information Age technological history should not neglect the connections between the technological event at hand and the current state of technology. The very essence of technology is that of an always-changing, highly adaptable, progressive and forward moving field. In keeping with that spirit of change and progress, interpretive programs should, if possible, include a section that highlights current projects and work, as seen in the three interpretive program case studies. The

[55] Tilden 24.

visitor may feel a greater connection to the history of the subject by relating it to the current technologies and problems the technologies are attempting to solve.

# CHAPTER 3

## THE BOLT, BERANEK AND NEWMAN SITE: HISTORIC SIGNIFICANCE

The Bolt, Beranek and Newman site is of comparable historic significance to the California state landmarks discussed in chapter two, and is equally worthy of historic recognition. The Internet and email are revolutionary innovations that have impacted the world in sundry ways. The implications of having infinite information at our fingertips, to be accessed by a touch of a button are almost inconceivable. It provides the opportunity to access information about almost anything or anyone, anywhere. It makes communication with those completely out of our physical realm effortless. The Internet has created a global community that transcends geographic distances, political boundaries, censorship and the limitations of traditional materials such as books and newspapers.

The case for the site's historic significance is made here according to the guidelines set forth by the National Register for Historic Places in order to provide the foundation necessary for considering any preservation- or interpretation-related activities for the site. Properties deemed eligible for listing in the National Register must fulfill the following criteria: 1) the property must possess historic significance in one of four areas of American history; 2) the property must possess integrity; 3) the property must be significant in relation to major trends of history at the local, state or national level; and 4) generally, the property must be at least fifty years old.[56] (There is an exception to the last criterion that allows for sites that have achieved significance in the last fifty years to be listed on the Register if they are deemed of "exceptional importance".) The BBN site is evaluated in regard to each of these criteria below.

**Statement of Significance**

The Bolt, Beranek and Newman site is historically significant on the local, state and national level for its association with the development of the ARPANET, the technological forerunner to the Internet. Contracted out to BBN by the United States Government in 1969, the ARPANET project's goal was to build the backbone of an experimental computer network. BBN's role in constructing the network ended in 1978, at which time the experiment was deemed a great success. ARPANET continued to run, and laid the technological foundation for the Internet. The site comprises several commercial and industrial buildings, constructed between the years 1952 and 1974. Architecturally, the structures are relevant examples of modernist design.

The Internet was not initially conceived of as the global network it is today; it was supposed to be a contained network that connected supercomputers at government contracted research centers so that resources could be shared and work would not be duplicated. This idea was conceived of within the Advanced Research Projects Agency of the Department of Defense, and was coined the ARPANET. When the Advanced Research Projects Agency sent out a request for proposals to the leading technology firms

---

[56] United States, Dept.of the Interior, National Park Service, National Register Bulletin: How to Complete the National Register Registration Form (Washington: GPO, 1997) 1.

in the county to build an experimental computer network called the ARPANET that would connect research institutions, most people, including companies such as IBM said it would be impossible to build. Bolt, Beranek, and Newman, on the other hand, was sure it could be done, and submitted a superior blueprint that outlined how they were going to build the network. Their proposal was so impressive, it was chosen over those of goliaths such as Raytheon.[57]

The proposed ARPANET was not to be the first computer network of any kind, but it was the first of *its* kind. There had been networking projects undertaken in the early 60s, including SAGE, a military project aimed at connecting radar stations and sharing information for defense purposes, and SABRE, a network developed by IBM that facilitated flight reservations for airlines (this technology was soon embraced by banks for ATM machines).[58] But there was a major difference between these networks and the ARPANET--the ARPANET was based on the innovative packet-switching technology, while the others ran on circuit-switching technology.[59] Packet-switching technology would revolutionize computer communication by enabling machines anywhere in the world to transfer data to one another in a fast, dependable way, without a dedicated line between the sender and the receiver.

From January of 1969 through the following year, BBN succeeded in building the basic components for the network, the Interface Message Processors (IMPs), and writing the code that would enable them to function correctly. By the end of the year, four universities were connected via the ARPANET. This was an impressive accomplishment

[57] See chapter one for a more in-depth description.
[58] Solymar, Laszlo, Getting the Message: A History of Communications (Oxford: Oxford University Press, 1999).
[59] See glossary of terms for definitions of packet-switching and circuit switching.

given that the company was treading upon entirely new technological ground. In *Getting the Message: A History of Communication*, communications expert Laszlo Solymar describes this aspect of the ARPANET project, in the following terms: "[They] had to start from scratch because the problem of computer communications was an entirely new one."[60] BBN's role within the ARPANET project, therefore, was to develop an entirely new form of technology, on which the ARPANET would run. Katie Hafner describes the work done by BBN on the IMPs as "the core" of ARPA's experimental network.

From the inception of the project, various individuals and groups outside of BBN made major contributions to the development of the project. The work of those from ARPA, the Network Working Group and the initial host sites was vitally important to the success of the project. The work done by BBN, however, represents the construction of the backbone of the network--which was an historic engineering feat. All work that was contributed to the project was built upon BBN's initial work with IMPs and software that enabled them to speak with one another.

In 1972, an engineer at BBN named Ray Tomlinson wrote a software program that enabled electronic mail to be sent over the ARPANET. This was the birth of email--a method of communication so popular that it has swept the world. Additionally, while working on this program, Tomlinson chose the "@" sign to serve as the separation between the mail sender's name and address. Since, the @ sign has become an icon of the Information Age.

The significance of the ARPANET lies in its direct relation to the Internet of today. BBN oversaw the functioning of the ARPANET until 1978. By that time, the

---

[60] Solymar.

ARPANET was a robust network that linked universities and other centers of research. Others networks based on the technology of the ARPANET had also been created by this time, most of which catered to the scientific community. At the time, few people saw use for this network outside of the science and academic communities, but the official project completion report from ARPA eluded to the idea in this statement: "This ARPA program has created no less than a revolution in computer technology and has been one of the most successful projects ever undertaken by ARPA. The full impact of the technical changes set in motion by this project may not be understood for many years."[61] This last sentence could not have been truer, as the technical changes set in motion by the ARPANET project led directly to the emergence of the Internet.

In the late 1970s and 1980s, the various networks began to be interconnected to form an "Internet". For the majority of those years, ARPANET was at the center of the web of networks. By the late 1980s, hundreds of new networks were woven into the Internet, and ARPANET, appearing somewhat antiquated next to them, was decommissioned. The Internet continued to grow, however, and with the invention of the World Wide Web in 1990, the Internet of today came into existence. The ARPANET was a pioneering experiment that laid the foundation for an entirely new method of communicating and accessing information.

---

[61] Computer History Museum, “Internet History and Microprocessor Timeline” 2003, from

**Description of Buildings**

Richard Bolt and Leo Beranek founded their company in 1948 and moved to their Cambridge, Massachusetts location in the early 1950s. As the company expanded, they purchased additional buildings on the street, and by the mid-1960s, the company occupied a row of five low warehouse style buildings dating from the early 1950s and 1960s. The buildings are boxlike, simple and practical in design, have flat roofs and few windows, and are solid examples of 1950s and 1960s modernism. Of particular interest is Building #2 which was constructed and designed by Richard Bolt himself. Unusual characteristics of the building include a foundation that "floats" in the Cambridge mud (the site is in close proximity to Fresh Pond) to prevent any external vibrations from penetrating the building, and an ability to withstand an extraordinary amount of weight (this was done to accommodate all of the academicians' books).[62]

The layout of the buildings reflects the structure of the company at the time of the ARPANET project. BBN was composed of two divisions: Information Sciences and Computer Systems. The former was composed of the academics with Ph.Ds, while the later comprised those who did the actual building (and did not have Ph.Ds for the most part). The two divisions did not regularly intermix and worked in separate buildings connected by an enclosed footbridge. The Information Sciences group was in Bolt's building, while the Computer Systems team was in Building #3, also known as "the factory". The loading dock on back of this building is where BBN took delivery of the

---

http://www.computerhistory.org

[62] Hafner 87.

Honeywell machines that would become their IMPs and it is in this building where the first IMPs were constructed (there is even an IMP room).[63]

In the mid 1970s, BBN purchased the dry cleaning store on the corner of Moulton Street and tore it down to build their new headquarters building (see figure 3.2). According to Hafner, the design of the new building has some intriguing influences:

> Architecturally, the style of the impressive new building subtly suggested a sleek fortress. Built at the height of the anti-war movement in the early 1970s, it reflected BBN's emerging corporate consciousness about antiestablishment threats to companies engaged in U.S. Defense Department contracting. The building had no windows on the ground floor, where a large computer center was located. It also had a basement parking garage designed so that the building itself stood back, surrounded by a substantial, waterless moat, allowing access to the front door only over a short footbridge.[64]

Unfortunately, this government contractor security issue is still a concern at BBN, so much so, in fact, that access to the interior of the buildings and additional information on their contents or layout could not be acquired. Therefore, the information presented here regarding the architectural integrity of the site is incomplete. It is apparent, however, that no significant changes have been made to the exterior portions of the buildings.

BBN's location within the city of Cambridge is also very significant. In the era of the ARPANET project, the company was often referred to as the "third university"[65] because of its tight connections with MIT and MIT's Lincoln Lab and Harvard. The academic and research-oriented atmosphere of Cambridge provided the perfect surroundings in which BBN could grow and flourish. Cambridge in the 1960s also saw a

---

[63] Ibid., 86-87.
[64] Hafner 168.
[65] Ibid., 86.

plethora of technology companies that either sprouted out of, or moved into Cambridge. These new companies, along with the existing universities, and companies turned Cambridge into a mecca for innovation. In his book *Cambridge, U.S.A.,* Christopher Rand describes this period: "In Cambridge you are in the mainstream of innovation. There is no other place like it… [it] really is the center now, for the spawning of new techniques."[66] According to Rand, this increase in technological activity in Cambridge played a major part in the city's 1960s "architectural boom."

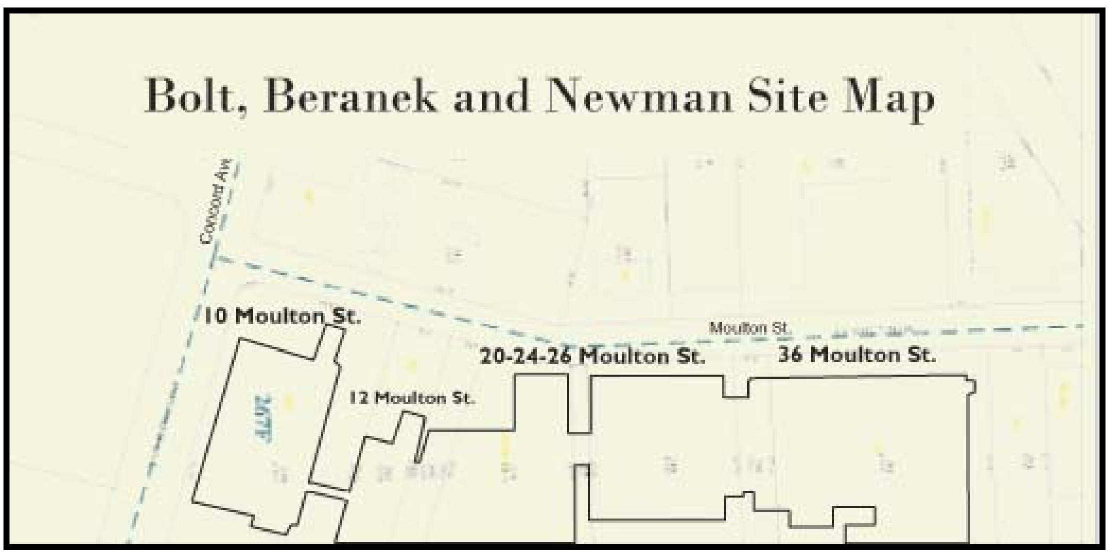


Figure 3.1. Bolt, Beranek and Newman site map

[66] Christopher Rand, Cambridge U.S.A.: Hub of a New World (New York: Oxford University Press, 1964) 180.

Figure 3.2. BBN building, 10 Moulton Street

Figure 3.3. BBN building, designed by Richard Bolt.

Figure 3.4. BBN building #3—"the factory."

Figure 3.5. BBN loading dock behind building #3.

# CHAPTER 4

# RECOMMENDATIONS FOR THE PRESERVATION AND INTERPRETATION OF THE BOLT, BERANEK AND NEWMAN SITE

The nature and characteristics of the Bolt, Beranek and Newman site set the stage for interesting and challenging methods of preservation and interpretation. On one hand, the site is of great historic significance, it possesses integrity in most areas, and is located within a technology-rich area where the field is highly regarded and is considered an integral part of the community. On the other hand, the site is only thirty years old (from its period of significance) and the buildings on the site are not publicly accessible due to security concerns. Additionally, there are very few artifacts and material objects to preserve and interpret in relation to the history of the ARPANET itself. The following proposed preservation and interpretative endeavors attempt to take both these advantages and disadvantages into account to provide viable possibilities for the site.

## Historic Designation

The site is virtually unknown to the general public, even the majority of those people who drive by it every day or live within close proximity to it. And although the Cambridge Historical Commission, the Cambridge Historical Society, and many Boston-area historians and high-tech industry professionals are aware of the BBN company and its connection to the Internet and other technological achievements, most do not know in what capacity BBN was involved with the Internet, or where the site is exactly located.

Therefore, the first step towards interpreting the BBN site should be to educate the community on the site's history and significance through official historic recognition by the City of Cambridge. This would require minimal financial resources to obtain, and could be completed in a relatively short period of time. Most importantly, this undertaking would require basic research of the site's history, a survey of the site and its structures, and input from area preservationists and historians. These elements combined would create an excellent foundation and gauge for further interpretive possibilities.

One such possibility is inclusion within the Cambridge Historical Commission's historic marker program that demarcates properties officially recognized by the city as being associated with significant events or persons. The program provides historic sites with highly recognizable signage that features a very brief description of the site's importance. Inclusion in this program would be a relatively small undertaking that would benefit the BBN site dramatically by simply drawing attention. There are over one hundred such markers across the city, many of which have been up for decades (the program was implemented for the Independence Day bicentennial celebration in 1976)[67], and most residents or regular visitors to the area immediately recognize the signs as historic markers.

The historic marker program does not provide any legal protection, as is afforded by local landmark designation or inclusion within a city conservation district. However, either consciously or subconsciously the marker draws people's attention to the site, subsequently making them aware of its significance; should the site be threatened in the future, these same people may take action to protect it.

---

[67] Sally Zimmerman, Personal Interview, 27 Feb. 2003.

When Sally Zimmerman, a representative from the Cambridge Historical Commission, was interviewed on the issue, she stated that a request for an historic marker for the BBN site would be seriously considered, and that in her opinion, the site would be an excellent candidate for inclusion in the program. When asked if there could be resistance to the request given that the site's era of significance was only thirty years ago, she said that would not preclude the site's acceptance to the program.[68]

National Register and local historic designation for the site should also be explored as soon as possible. Although both such designations require that sites generally be at least fifty years of age to meet eligibility requirements, a strong case could be made for an exception given the BBN site’s exceptional importance. Inclusion in the National Register would provide added awareness of the site, as it would be recognized on the state and national levels. Unlike the historic marker program, properties listed in the National Register are afforded some legal protection. This protective measure comes into play in case the site is threatened by a federally-funded project, and requires that a review of the project's impact on the site be completed and assessed by the State Historic Preservation Office. This review process cannot enforce the protection of the site, but it can make a strong case to the state for its protection, and also hinders the ability for such projects to destroy historic resources quietly, with no one the wiser until it is too late. National Register listing also makes owners eligible to receive tax credits for rehabilitation of the property- an added incentive for the site’s preservation. While National Register listing should be pursued in the future, great effort should also be made

[68] Ibid.

to acquire local historic designation--it would provide far greater protection for the site by requiring the approval of any alterations by the Cambridge Historical Commission.

**On-Site Interpretive Programs**

An historic marker and local, state or national designation will greatly increase the visibility of the BBN site to both the public and to area preservationists and historians. Far more could be done, however, to bring the story of the ARPANET and Bolt, Beranek and Newman to the public. If the purpose of interpreting historic resources is to educate those who seek to learn about the topic, the interpretation should make the information as easily accessible and as palatable as possible. An on-site interpretive exhibit would provide visitors with the opportunity to learn about the history of the ARPANET while fully immersed in the BBN environment.

This section offers hypothetical proposals for an interpretive exhibit at the BBN site. The specifics of exhibit design and contents are not covered, as that would be another project altogether. However, suggestions are offered in regard to general interpretive elements that might be appropriate in such an exhibit, primarily based upon the findings of chapter two. While many of the suggestions offered here are based on the author's personal experience and preferences, a basic outline for planning an interpretive program is provided, and could be referred to by anyone considering undertaking such a project. The proposal is divided into two sections- first, the planning process and second, suggestions for general interpretive methods.

**Proposed Program: Interpretive Exhibit**

The proposed interpretive program would comprise a small, on-site interpretive exhibit, located within an existing building on the BBN site, or within a building newly constructed for this purpose. The exhibit would present the history of the ARPANET, as the origin of the Internet, to visitors. It would be very small in scale, inexpensive to operate, and not dependent on revenue from ticket sales for its survival. Depending on the circumstances under which it was built, the exhibit may be designed in such a way that moving it to another location on-site or off-site, such as a museum, would be possible. This would ensure the long-term survival of the exhibit regardless of future changes or developments within the site itself.

*Planning*

The first step towards an on-site interpretive exhibit is an extensive and thorough planning process. This process includes defining the objective of the exhibit, taking inventory of available resources (including funds, artifacts and space), and outlining the themes or stories on which the exhibit would focus.

The objective of an exhibit at the BBN site, primarily, would be to educate people on the history of the ARPANET, as it is related to the Internet. While BBN has a long list of impressive technological accomplishments, not only in the areas of computing, but also in acoustics and other technologies, its work on the ARPANET is of primary historic significance. This objective should be revisited frequently throughout the entire planning process.

The source of funding for the exhibit is probably the first hurdle to be encountered when undertaking this type of project. It has been made clear through interviews with

BBN representatives that the company would not have the ability to dedicate funds to a project such as this. Joyce Kuzmin explained that although the firm's impressive history is major part of their identity and marketing strategy, they could not fund a major project that did not have a direct business development goal.[69] Therefore, other sources of funding must be explored and pursued. A survey of possible funders may be one of the very first steps in the planning process, but grant proposals and other requests for funding should not be pursued until a clear outline of the exhibit has been completed and can be presented. The Cambridge-area universities, including MIT and Harvard are potential sources for funding. Others include the Cambridge Office of Travel and Tourism, grant programs through the city and state, and area technology trade associations such as the Massachusetts High Technology Council. Other possible donors are individuals and corporate sponsors (although the latter is very unlikely since BBN is a corporate entity.)

One of the most influential factors in determining the make-up of a traditional exhibit is the artifact and object collection. While the number of artifacts will be very small in an exhibit such as this, it is still important to determine which objects are available for use in the exhibit. Artifacts still in possession by BBN should be inventoried and any artifacts that have been loaned or donated to other museums or organizations should be identified and located. Whether or not these artifacts could be returned to BBN for this exhibit should be determined. Other artifacts that should be inventoried include video footage, oral histories, historic documents and photographs, and other relevant information.

---

[69] Kuzmin interview.

As with artifacts, it is necessary to inventory space available for the exhibit. One of the most important questions regarding this exhibit would be what role the actual site plays within the interpretive program. This would be dependent on the current use of the site. Ideally, the room where the IMP was constructed could be considered as a possible location for the exhibit. However, given that BBN still occupies the entirety of the buildings and security issues exist, this will not be an option in the near future. If it is evident that the site contributes little the interpretive program, the exhibit could be located at an alternate site, and should be designed with that in mind. The fact that BBN still occupies the site is significant in itself, however, and it is possible that the company would welcome an interpretive exhibit on the site in a separate facility that would increase visibility of the company and also be an excellent promotional vehicle for clients.

It was established in chapter two that the themes on which the exhibit focuses are of the utmost importance in creating a successful exhibit that is compelling to the visitor. The details of the technology behind the ARPANET are not going to fascinate most people, and therefore, themes more universal in nature should be focused on in the program. It is clear that the central theme of the exhibit would be the history of the ARPANET and how it gave birth to the Internet. This is the crux of the site's historic significance and should be the primary focus of any interpretation. However, additional themes must be developed for the exhibit to give people the opportunity to relate the information to their own lives and experiences. Possible themes to be included in BBN interpretive exhibit are:

*Theme #1: The environment that gave rise to the ARPANET*

This theme would explore the situations (social, political and otherwise) out of which the ARPANET sprang. Specifics could include: the launching of Sputnik and the subsequent fear in America, Eisenhower's and others' assuredness that science was the key to a successful American future, and America's determination to be the world superpower. This theme provides context for the ARPANET and would likely relate the topic to visitors' lives. Some visitors would actually remember that era, whereas younger visitors would be able to consider how that determination shaped the America of today.

*Theme #2: The ARPANET/Internet was a truly collaborative project*

The collaborative nature of the ARPANET project is of great importance to understanding the roots of the Internet. It should be clarified that there were many individuals and institutions involved with the project, and that no one single person or entity can take credit for inventing the Internet. From the project's conception, many different individuals worked together to make it a reality. At the same time, BBN's success in constructing the foundation of the Internet can be attributed to the collaboration among the team that was assembled within the company. The relatively small team was so skilled it was able to win out over goliaths like Raytheon and to persevere when most others said it could not be done. In the exhibit, this theme would encompass the stories of the BBN team members and how each one had a specific talent that was vitally important in the success of the project. This is also reflected on a larger level with BBN providing the backbone for the ARPANET, but with the teams at the host sites and the Network Working Group working on the protocols and connecting the host computers to the IMPs. Much of the work that was done by these other groups involved no contracts or payment, but just passion and determination to make this project a success.

The theme of working together towards a common goal is a universal one that often instills feelings of great inspiration and hope. Stories of groups of people coming together to accomplish the seemingly impossible are among the most popular that have been told throughout history.

*Theme #3: The impact that ARPANET has had on the world*

The initial goal of the ARPANET was to share information and resources between a small number of supercomputers located at research institutions. The goal of the project was to create easier access to information and greater efficiency by eliminating the duplication of research. The initial architects of the ARPANET, as far as we know, had no idea that this network would evolve into a worldwide network that connected computers of all types all over the globe. This theme can explore the questions of why did this seemingly small and contained network grow exponentially? Why are we so hungry for information? This theme will frame the explanation of the ARPANET-Internet connection, and provoke visitors to ponder how the Internet has affected their lives and our collective society. It will also prompt them to consider the amount of information that is accessible to them through the Internet.

*Interpretive Elements*

This section must be prefaced with a clarification that what follows is not a specific design for an interpretive exhibit at the BBN site. Rather, potential elements that might be effective when employed within a larger exhibit are offered.

It is evident that exhibits that focus on Information Age technological history are likely to encounter more interpretive challenges than traditional museum exhibits. While the collection is usually of primary importance in history and art exhibits, ideas and concepts are paramount in most technology exhibits, with no exception for the case at hand. Therefore, technological artifacts will play a lesser role than other types of elements that may be able to convey the ideas and themes more successfully. An effective exhibit format would feature individual sections that focus on a specific theme. This creates a format of displays that do not have to be viewed in sequential order. Possible elements to enhance the interpretive themes are listed below.

Elements for Theme #1:

- Looping video footage of a televised news report announcing the launch of Sputnik.
- Quotes, letters, or other material that describe Eisenhower’s dedication to furthering research and to "his scientists."
- Magazine covers or newspaper headlines that convey 1) the American response to Sputnik; 2) the belief that science was the key to the future; 3) how Americans envisioned the future of science.

Elements for Theme #2:

- Video loops of interviews with BBN team members and others involved with the ARPANET project that provide first-hand accounts of working on the project.
- Highlight personalities and feature humorous anecdotes from the employees.

- A few significant machine artifacts- specifically the IMP (to be accompanied with interactive display).
- Interactive exhibits to convey the concepts of protocol and other software.
- Video or other media featuring explanations behind decisions, such as how Ray Tomlinson chose the @ sign.
- Primary documents such as the RFQ, initial sketches of network (particularly those done on cocktail napkins), and the letter from Senator Kennedy that congratulated the company of their "Interfaith Message Processor."
- Interactive exhibit to convey concept of packet-switching technology.

Elements for Theme #3:

- Multi media map of first host sites early stages of ARPANET- to show which sites were involved (and why) and the rate at which the network grew.
- Interactive survey regarding visitor's feeling about the Internet- possibly regarding free speech or censorship (BBN and other networking pioneers felt very strongly from the beginning that the Internet should always remain open). People like to give their opinion on things- see how their opinions compare with those of others.

Additional Elements:

- Revolving Exhibit Space in which BBN could display information on other or current projects.

The few select artifacts displayed in the exhibit should be brought to life through accompanying elements, such as video loops of interviews with BBN employees. To avoid alienating visitors, all machine artifacts should have some element of personal connection, either to the visitor, someone featured in the BBN story, or society at large. Additional artifacts and objects such as BBN documents, media samples and maps of the ARPANET should be presented in relation to the corresponding theme in order to provide context and meaning for the visitor. The current projects display provides an added dimension of meaning and context for the history of the ARPANET and BBN.

Although dependent on the level of funding for the project, interactive displays that reveal the essence of the technology behind the ARPANET would be highly effective. As discussed in chapter two, a hands-on approach may be one of the most effective ways to inspire learning.

These elements, as included within a comprehensive exhibit, would facilitate the relation of the subject to the lives of the visitors and possibly result in an altered perception of the Internet and the technology behind it. Perhaps peeking into the history of the ARPANET would provoke a sense of wonder and awe, or of appreciation and gratitude in regard to the extraordinary technological innovation.

***Other Possibilities for On-Site Interpretation***

An on-site exhibit is one possible route for interpretive programming for the BBN site. There are, however, many other possibilities for interpretation of the site's history of which only a couple can be briefly mentioned here.

A logical component of a BBN interpretive program would be a virtual museum that could be accessed on the Web. Visitors to such a "museum" could take a virtual tour of the site, view and listen to audiovisual elements such as oral histories, download various images and historic documents, and read in-depth or brief narrative histories of the ARPANET. (Note: the Museum of Science attempted this as an added dimension to the *Computing Revolution* exhibit and decided it was not a worthwhile undertaking unless substantial resources were available for its development—which wasn't the case. They felt that the site would come across as extraneous and therefore, they should not just "wow people with technology just for the sake of it.")[70] The Intel Company, on the other hand, has an excellent on-line museum that features creative and entertaining activities that relate the history of the company, in addition to tours, photographs of collections, interviews and much more.[71]

A second, less traditional method of interpretation would be the installation of a public art project at or adjacent to the site. This could potentially be one of the most effective ways to bring attention to the site should an exhibit space not be feasible or viable. The nature of the ARPANET itself would be a perfect subject matter for such a project, as the implications, the breadth, and the virtual nature of the technology would be easily lent to expression through art. The Cambridge Arts Council actively administers a public art program. The program description is as follows:

> Well over one hundred artworks have been publicly sited in Cambridge through the Cambridge Public Art Ordinance since the Ordinance was approved in 1979. Commissioned for capital improvements, the art is lasting evidence of the City's ongoing pursuit to enhance its physical environment. Never intended as mere adornment of buildings or spaces, however, the art provides an amenity for diverse groups of citizens. The emphasis is on the people who use the facilities -- on improvement as enrichment of public life. It has been the goal of the Public Art Program from the beginning to respond to the City's diverse communities and most of the artworks have indeed been created in active response to the character and history of their particular places. Behind each is a story, often involving artists in complex exchanges with large numbers of

[70] Rodley.
[71] Can be found at http://www.intel.com/intel/intelis/museum.

> community members. The means of engagement may vary with changing notions of the artist's role in society but the aspiration to respond to public life has remained unchanged throughout the program's two decades.[72]

Within Cambridge there is a technology community- an increasingly large group of institutions, companies, and most importantly people who work in the field and make highly significant contributions to both the city and the field of technology. The technology industry has had a great impact on the economic, architectural and cultural development of Cambridge. A public art project in proximity to the BBN site could express and celebrate this history and presence of that community.

**A Cambridge Technology Trail**

Building upon the focus of BBN's role within the larger Cambridge community, the next proposal is for the development of a Cambridge technology trail. One of the BBN site's strongest advantages as a historic site is its location within a city that is home to hundreds of high-tech, biotechnology and other technology companies, in addition to institutions and universities whose research and work is on the cutting-edge of their fields. In fact, the Cambridge area has been a seedbed of innovation and invention for over a century.

Home of MIT, Harvard University, biotechnology companies such as Biogen and Genzyme, Poloroid, the Whitehead Institute and Raytheon, Cambridge has been home to great innovations that have changed the world and the lives of those in it, such as the mapping of the human genome, the development of radar and the microwave oven, and

---

[72] Cambridge Arts Council, "Public Art Program" 2002-2003, from http://www.ci.cambridge.ma.us/~CAC/public_overview.html.

the bio-engineering of life-saving bio-pharmaceuticals. In the field of computing, Cambridge has seen some of the most important advances in the field, including the development of some of the first supercomputers, the personal computer, the electronic spreadsheet, and the ARPANET.

This rich history of technology in Cambridge is widely acknowledged, but has yet to be celebrated by the city through preservation or other heritage programs. Perhaps the Cambridge and Boston area's deep roots in the American Revolution and its reputation as a staid, conservative city where change is met with suspicion and resistance make twentieth-century technological innovations an unlikely historic focal point. Unlike the Silicon Valley area in California where sites of early computer innovations are already designated as State Historic Landmarks, it appears that preservationists in the Cambridge area have yet to identify with the city's technological history to the same extent. This could change, however, with the creation of a Cambridge "technology trail" that would identify sites or areas of historic significance in the area of technology, and make the history accessible to the public (figure 4.1).

The "trail" concept is not a new one in the Boston area. The most popular tourist attraction in the city of Boston is the "Freedom Trail," which is comprised of dozens of historic sites associated with the American Revolution that are connected with a simple red line on the ground for visitors to follow from site to site. The success of this concept has led to the development of other trails in the Boston area. One of particular interest is the “Innovation Trail,” a theatrical bus tour that tells the stories of the inventions and innovations in Boston and Cambridge. (This tour mentions, but does not pass by or stop at the BBN site.)

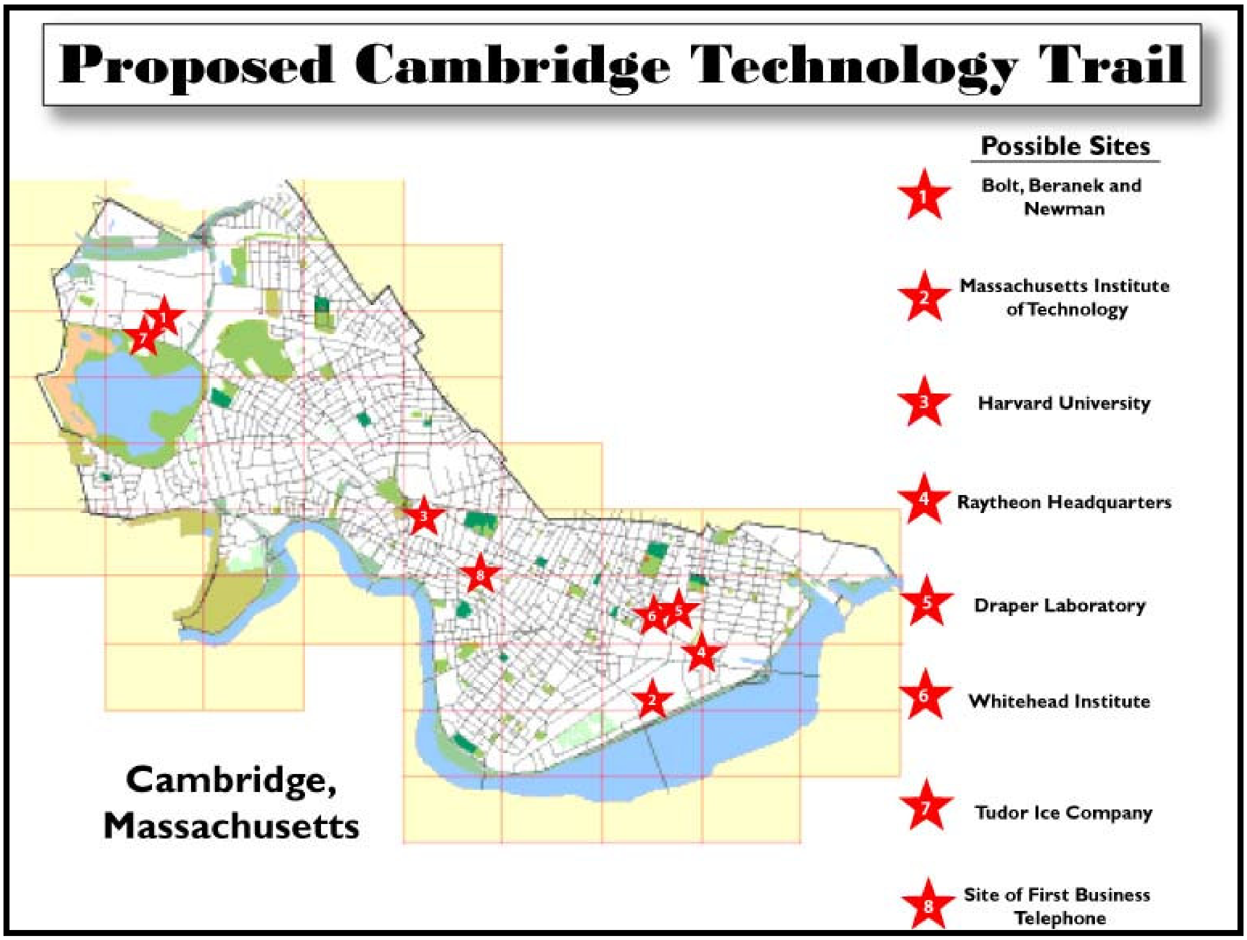


Figure 4.1. Cambridge technology trail: possible sites

The Technology Trail proposed here would not be based on the model of either of the previously mentioned trails. Rather, it would be administered by the Cambridge Historical Commission and based upon their model used for an existing Cambridge African-American Heritage Trail. This model includes installing signage that is visually unique from the historic markers and provides more in-depth information (see figure 4.2). A booklet is also published in coordination with the installation of the signage that describes the sites and people of the trail in great detail, along with basic information on the sites, such as addresses. The booklet can function both as a guidebook for a self-guided tour of the trail or as an interpretive medium on its own. It would be available at local bookshops, university visitor centers, and other information centers for a minimal cost.

The Cambridge Historical Commission feels that a technology trail would be of substantial value to the city, and should the opportunity present itself, they would be willing to initiate the process.[73] The Cambridge mayor's office also said that the city would support undertaking of the project.[74] The only apparent issue standing in the way of a technology trail is funding. Completing this project would require expensive research, writing, and editing, in addition to production costs for the signs and booklets. Deciding which sites should be featured on the trail would require extensive staff time. It is clear that the city does not have the ability to provide these funds, and therefore, they

---

[73] Kuzmin.
[74] Ibid.

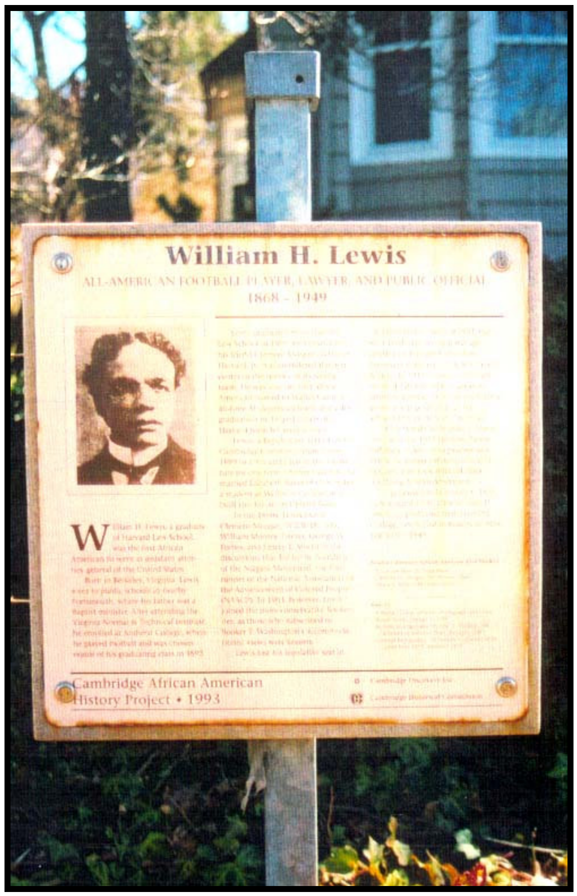


Figure 4.2. Cambridge African-American Heritage Trail marker

would have to be procured elsewhere. Possible sources would include those listed for the on-site exhibit. Trade organizations such as the Massachusetts Biotechnology Council, the Massachusetts Software and Internet Council, and the Massachusetts High Technology Council often provide funding for educational programs that contribute to the understanding and visibility of their industries, and a technology trail would accomplish exactly that.

A Cambridge technology trail is a highly viable project that the Historical Commission has already considered undertaking in the future, and will be supported by most, if not all, of the organizations and entities involved. Cambridge residents would have the opportunity to learn about the technological history of their city, while visitors would have another option for site seeing during their stay. Visitors and residents in Cambridge are probably more inclined than the general public to be interested in the subject given that many are in the city because of a connection with one of the companies or institutions themselves. If included in such a trail, the BBN site would benefit greatly in terms of visibility, and should an on-site exhibit be installed, visitor attendance would certainly increase as a result.

## CONCLUSION

It can be said that the human experience is shaped by time and space. From the moment we arrive in the world, our lives unfold in a series of measured increments of time, often down to the minute. We are thirty years old, we will have dinner at 7:30, we will sleep for eight hours, we will get up at 6:00 AM to make it to work by 8:15 AM, and so on. All of these experiences also occur within a physical space that greatly influences our opportunities, our actions, our thoughts and our feelings. Both of these dimensions frame our lives and provide structure for them; but time and space also limit our possibilities. Were the confines of time and space nonexistent, we could instantaneously be anywhere at any time. No person, no work of art, no natural wonder, no information would be beyond our reach.

While the negation of time and space is not yet in our technological repertoire, the technology of the Information Age continues to work to break down the barriers to communication and accessing information, such as time and space. Information Age technology has made nearly instantaneous communication with others, regardless of their location on the planet possible, as is immediate access to information from all over the world so long as it connected to the Internet. These advancements have had enormous implications for our lives and our cultures, some positive and some less so, in addition to decimating the amount of physical material previously required to serve as vehicles for information and communication. Nearly gone are the days of the handwritten letter and manuscript and in their place are the days of libraries worrying about becoming obsolete receptacles. As we move deeper into the Information Age, we move further away from physical space and material. This has enormous implications in regard to historic preservation.

As sites associated with the birth of the Information Age near fifty years of age, preservationists will soon be faced with questions regarding the preservation of these sites and their history. At first glance, many people might say that the preservation of such sites and history is paradoxical. The very essence of technology is progress and evolution, not history and inertia. David Lowenthal describes the common perception that history and innovation do not mix: "…people realize that tradition *is* a brake on progress. They may acknowledge the virtues of yesteryear and the benefits of relics and roots, but they also know that the old has to give way, that youth must be served, that new ideas need room to develop-that the past does indeed constrain the present."[75] Particularly in the field of technology, a culture exists to not look to the past, but only to the future; many are taught that history only stifles progress.

This provokes many questions: does the preservation of Information Age history rob the history of its very essence? And do we want to preserve the technology that is contributing to the increasingly ephemeral nature of material culture in the first place? If preservation is pursued, how does one preserve the history when there is little, if no, physical representation of it?

Information Age technology is undoubtedly contributing to an increasing trend of impermanence in our culture, in regard to material, location and tradition. Technology is

[75] David Lowenthal, The Past is a Foreign Country (Cambridge: Cambridge University Press, 1985) 69.

evolving so rapidly it is becoming near impossible to keep up with the innovations of the day. This is a defining characteristic of this era of time. Peter Marris points out that, "The more rapidly society changes, the less readily should we abandon anything familiar which can still be made to serve a purpose. The townscape ought to reflect our needs for continuity."[76] This argues for the importance of preserving these sites, as over time they will or have already become familiar elements of the community, in addition to being sites where significant historic events have occurred.

How to go about preserving and interpreting them presents another set of challenges, particularly in regard to materials. There may be resistance to the designation should the site lack any architectural significance or fail to reflect the historic event in any way. Considering that most Information Age technology development occurs in virtual space rather than physical space, there may be very little connection to the actual structure in which it was developed. The increasing scope of preservation activity is described by Lowenthal in the following: "Many communities wish to save structures and scenes that would never qualify as 'aesthetic' or 'historic'…Preservation in this spirit extends to the industrial landscape…Yet congeniality remains a prime motive for preserving; most survivals are treasured for their beauty or harmony."[77] While it may be becoming more common for sites lacking in significance or appeal in the architectural or aesthetic realms to receive historic designation, most sites are still valued for these characteristics. Therefore, greater effort may be required in establishing the site's historic significance and overall worth to the larger community.

---

[76] Ibid., 399.
[77] Ibid., 388.

Interpretation of these sites and their history also presents challenges. With fewer artifacts and materials with which to work, the focus of interpretive programs must shift from objects to ideas and concepts. This focus requires innovative methods of interpretation, including interactive exhibits and multimedia displays. In order to relate the information to peoples' lives, it must be presented in relevant themes that connect the information to the larger world. The interpretive program should inspire visitors to broaden their horizons and think about the extraordinary impact that information technology has had on their lives, rather than solely present to them artifacts of the past.

The site of Bolt, Beranek and Newman is an excellent example of the type of site preservationists will be required to consider in the next few decades. We see that many of the traditional methods of preservation and interpretation would be applicable to Information Age technological history. There must be compensation, however, for the unique characteristics of Information Age technological history when applying these methods.

Regardless of the differences between Information Age technological history and other types of history, the goals of preservation and interpretation remain the same: to preserve history and present the related information and resources in a way that fosters an understanding for the visitor. The preservation of Information Age technological history may appear a bit paradoxical, but the technology associated with it has changed the world dramatically, and therefore, it is the duty of preservationists to seriously consider the value of such sites and to devise effective ways in which to preserve them.

## WORKS CITED

Alderson, William and Shirley Payne Low. Interpretation of Historic Sites. United States: The American Association for State and Local History, 1976.

Anderson, Christopher. "The Accidental Superhighway." The Economist 1 July 1995.

ARPANET Celebration. Video created by GTE Internetworking.

BBN Technologies: An Oral History. Video created by Marketing Services. BBN, 1998.

BBN Technologies. BBN Technologies: Where the Possible Becomes Real. Cambridge: BBN Technologies, 2002.

Beck, Larry and Ted Cable. Interpretation for the 21st Century. Illinois: Sagamore Publishing, 1998.

Cambridge Arts Council, "Public Art Program" 2002-2003, from http://www.ci.cambridge.ma.us/~CAC/public_overview.html.

Computer History Museum. "Internet History and Microprocessor Timeline" 2003, from http://www.computerhistory.org.

Charles, Barbara Fahs. "Exhibition as (Art) Form". Past Meet Present: Essays about Historic Interpretation and Public Audiences. Ed. Jo Blatti. Washington, DC: Smithsonian Press, 1987.

Ettema, Michael. "History Museums and the Culture of Materialism" Past Meets Present: Essays about Historic Interpretation and Public Audiences. Ed. Jo Blatti. Washington, DC: Smithsonian Press, 1987.

Falk, John H. and Lynn D. Dierking. The Museum Experience. Washington, DC: Whalesback Books, 1992.

Finucane, Martin. "Creators of the Internet Forerunner Gather in Boston." Reading (Mass) Daily Times Herald 12 Sept. 1994.

Greengold, Jane. "What Might Have Been and What Has Been-Fictional Public Art about the Real Past." Past Meets Present: Essays about Historic Interpretation and Public Audiences. Ed. Jo Blatti. Washington, DC: Smithsonian Press, 1987.

Hafner, Katie and Matthew Lyon. Where Wizards Stay up Late. New York: Touchstone, 1996.

Hall, Margaret. On Display: A Design Grammar for Museum Exhibitions. London: Lund Humphries, 1987.

Hosmer, Charles B. "The Broadening View of the Historical Preservation Movement." Material Culture and the Study of American Life. Ed. Jan M.G. Quimby. United States: The Henry Francis du Pont Winterthur Museum, 1978.

Kantrowitz, Barbara and Adam Rogers. "The Birth of the Internet." Newsweek 8 August 1994.

Kuzmin, Joyce. Personal Interview. 14 Jan. 2003.

Lebow, Irwin. Information Highways and Byways: From the Telegraph to the 21st Century. New York: IEEE Press, 1995.

Lowenthal, David. The Past is a Foreign Country. Cambridge: Cambridge University Press, 1985.

McFall, James. "Ground Zero Proposal." Palo Alto Weekly (online edition) 1996.

Naughton, John. Brief History of the Future: From Radio Days to Internet Years in a Lifetime. New York: The Overlook Press, 2000.

Neal, Arminta. Help for the Small Museum: Handbook of Exhibit Ideas and Methods. Colorado: Pruett Publishing Company, 1987.

Nua.com. "How Many Online?" Ireland: Computer Scope Ltd., 2003.

Pekarik, Andrew J., et al. Information Age: People, Information and Technology. Washington: Institutional Studies Office, Smithsonian Institution, 1997.

Rand, Christopher. Cambridge U.S.A.: Hub of a New World. New York: Oxford University Press, 1964.

Risk, Paul H. "Interpretation: A Road to Creative Enlightenment." CRM: Using the National Register of Historic Places 17.2 (1994): 37, 40.

Rodley, Ed. Personal Interview. 14 Jan. 2003.

Rodley, Ed. "Bringing Computing to the Public." Boston: Museum of Science, 2003.

Salus, Peter. “Pioneers of the Internet.” Internet World September 1994.

Segaller, Stephen. Nerds: A Brief History of the Internet. New York: TV Books, 1999.

Solymar, Laszlo. Getting the Message: A History of Communications. Oxford: Oxford University Press, 1999.

Smithsonian Institution. National Museum of American History. “Information Age: People, Information and Technology Exhibition”, from http://americanhistory.si.edu/youmus/ex18infa.htm.

State of California. Department of Parks and Recreation. Office of Historic Preservation. California Historical Landmarks Guidebook. Sacramento, 1995.

Tilden, Freeman. Interpreting our Heritage. Chapel Hill: University of North Carolina Press, 1977.

United States. Dept. of the Interior. National Park Service. Telling the Stories: Planning Effective Interpretive Programs for Properties Listed in the National Register of Historic Places. Washington: GPO, 2000.

United States. Dept.of the Interior. National Park Service. National Register Bulletin: How to Complete the National Register Registration Form. Washington: GPO, 1997.

Zimmerman, Sally. Personal Interview. 27 Feb. 2003.

Zitner, Aaron. "A Quite Leap Forward into Cyberspace." The Boston Globe 11 Sept 1994.

Zuckerman, Laurence. "BBN Steps Out of the Shadows and into the Limelight." New York Times 17 July 1995.

# APPENDIX A

## GLOSSARY OF NETWORK TERMS[78]

**Circuit Switching:** the method whereby a telephone call can be made, with a wire circuit linking one user to another; whether one talks or not, the circuit remains switched through, until one party hangs up.

**Data Sharing:** an original goal of computer networking, and of the ARPANET, whereby individuals at different locations could access and share the data of others at other locations, and vise versa. Not, as it turned out, very much used.

**E-mail:** electronic mail. Invented at Bolt, Beranek, and Newman.

**Ftp:** File Transfer Protocol. One of the first applications developed for the ARPANET, it's still used to send and retrieve files across the Internet.

**IMP**: interface Messaging Processor - these were the minicomputers that connected each node on the ARPANET to the network. Built by BBN, each was a refrigerator-sized Honeywell DDP-516 computer with a whopping 12k of memory.

**Internet:** an internet is a group of networks connected together. The Internet (note the capital "I") refers to the global connection of networks around the world.

**IP** - Internet Protocol, a protocol telling how packets on an internet are addressed and routed. The second part of TCP/IP.

**Mainframe** - a large, multi-user computer. Before personal computers were available, businesses and universities purchased large and expensive mainframes and housed them away in large, air-conditioned rooms.

**Node:** a location on a network. The ARPANET's first nodes were UCLA, Stanford, UC Santa Barbara, and the University of Utah.

**Packet switching:** the most efficient way to send data, by breaking a block of information into smaller pieces called packets, and each packet makes its ways through the network, to be put back together at the destination.

---

[78] Segaller 395-398.

**Protocol:** the rules of diplomacy among computers and related machines. Protocols define how networks organize communication among their own nodes, or between networks.

**Software:** the instructions that tell computer hardware what to do, applications and programs consisting entirely of zeroes and ones, with no physical substance.

**TCP/IP** - Transmission Control Protocol/Internet Protocol, first defined by Vint Cerf and Bob Kahn in 1973, the protocol made the Internet possible and has become the default network protocol around the world.

**World Wide Web:** the software Tim Berners-Lee invented to “translate” material from any computer, from any format, into a common language of words, images and addresses.

# APPENDIX B

## SELECTED INFORMATION AGE TECHNOLOGICAL HISTORY MUSEUMS IN THE UNITED STATES

### Traditional Museums

| Name | Website |
| --- | --- |
| Compuseum, Bozeman Montana | www.compustory.com |
| Computer Museum of America, San Diego, CA | www.computer-museum.org |
| Computer History Museum, Mountain View, CA | www.computerhistory.org |
| Microsoft Museum, Redmond, CA | www.microsoft.com/museum |
| Charles Babbage Institute, Minneapolis, MN<br>Intel Museum | www.cbi.umn.edu |
| Infoage, Wall, NJ | www.infoage.org |

### Online Virtual Museums

**Name and Web Address**

HCS Virtual Computer History Museum
www.cyberstreet.com/hcs/museum/museum.htm

Intel Museum
www.intel.com/intel/intelis/museum

Obsolete Computer Museum
www.obsoletecomputermuseum.org

Virtual Altair Museum
www.virtualaltair.com

University of Virginia Computer Museum
www.cs.virginia.edu/brochure/museum.html

Virtual Museum of Computing
www.vmoc.museophile.com